

South Dakota State University

Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange

Theses and Dissertations

1968

Movements and Behavior of Pheasants During the Breeding Cycle as Determined by Radio-Tracking

Thomas L. Kuck

Follow this and additional works at: <http://openprairie.sdstate.edu/etd>



Part of the [Natural Resources and Conservation Commons](#)

Recommended Citation

Kuck, Thomas L., "Movements and Behavior of Pheasants During the Breeding Cycle as Determined by Radio-Tracking" (1968). *Theses and Dissertations*. 158.
<http://openprairie.sdstate.edu/etd/158>

This Thesis - Open Access is brought to you for free and open access by Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange. It has been accepted for inclusion in Theses and Dissertations by an authorized administrator of Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange. For more information, please contact michael.biondo@sdstate.edu.

MOVEMENTS AND BEHAVIOR OF PHEASANTS DURING THE
BREEDING CYCLE AS DETERMINED BY RADIO-TRACKING

BY

THOMAS L. KUCK

A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Major in
Wildlife Management, South Dakota
State University

1968

SOUTH DAKOTA STATE UNIVERSITY LIBRARY

264123

MOVEMENTS AND BEHAVIOR OF PHEASANTS DURING THE
BREEDING CYCLE AS DETERMINED BY RADIO-TRACKING

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.





ACKNOWLEDGMENTS

I am most grateful to Dr. Donald R. Progulske for his counseling throughout the study and his assistance in preparing this manuscript. I wish also to thank Dr. Raymond L. Linder for his valuable suggestions concerning the manuscript.

Special thanks are extended to Lyle Petersen who was most helpful in offering aid and repair of telemetry equipment.

I am most deeply indebted to Robert B. Dahlgren, for his active interest, assistance in preparation of the manuscript, personal assistance in the field and cooperation in setting up the study. Had it not been for his care, thoughtfulness and guidance the project would not have been a success.

Thanks are extended to Wilbur C. Foss for his assistance with field equipment.

Appreciation is extended to Robert Jorgensen and James Messerli who were my very able assistants during the study.

Lastly, I am most grateful to my family and parents for the hardships endured by them during the course of my study and their encouragement for my continuing to work towards an advanced degree.

TLK

MOVEMENTS AND BEHAVIOR OF PHEASANTS DURING THE
BREEDING CYCLE AS DETERMINED BY RADIO-TRACKING

Abstract

THOMAS L. KUCK

Behavior and movement studies were carried out on the Rifle-Calahan Study area, Sanborn County, South Dakota, in 1965 and 1966.

Objectives of the study were to evaluate radio telemetry techniques, determine the territorial area and home range of the hen and cock, study the behavior pattern of hen and cock in the harem makeup, determine the distance traveled by the hen when attracted to the harem, determine if the hen nests in the immediate area of the crowing territory, and study the behavior of the hen while nesting and caring for the brood.

Twenty adult pheasants (16 hens and 4 cocks) were monitored with radio telemetry equipment designed by Sidney Markusen of Cloquet, Minnesota.

The home range of the hen averaged 28.5 acres and did not appear to be strongly tied to the crowing territory of the cock. It encompassed all movements while feeding, mating, nesting and caring for the young. The activity center of the hen covered 5-10 acres surrounding the nest. Activity centers of the two cocks marked in 1966 covered 4 and 8 acres, respectively, in the home range where crowing occurred.

The oestrus cycle of the hen pheasant in South Dakota lasts about two weeks during early nesting attempts, and 9-10 days during renesting attempts.

Egg laying occurred after mid-day with the hen spending an increasing amount of time on the nest as the incubation period approached. Rest periods during incubation occurred most commonly in the afternoon around 5:00 p.m.

Hens cared for their broods in the near vicinity of the nest until the chicks were about three weeks old.

Renesting interval for instrumented hens was about 10 days. Second clutches were smaller than first clutches.

Instrumented cocks tended to select knolls relatively free of tall vegetation as their crowing sites and ceased crowing about July 1.

TABLE OF CONTENTS

	Page
INTRODUCTION	1
DESCRIPTION OF AREA	4
METHODS AND MATERIALS	7
Capture Techniques	7
Marking Devices	7
Locating Marked Birds	9
Field Battery Life	12
RESULTS	16
System Error	16
Reactions of Birds to Transmitters	17
Interpretation of Pheasant Activity	18
Movement and Behavior Determined By Radio Location	19
INTERPRETATIONS OF MOVEMENTS AND BEHAVIOR OF MONITORED	
PHEASANTS	45
Female Pheasants	45
<u>Home Range</u>	45
<u>Prenesting and Egg-Laying</u>	46
<u>Oestrus Cycle</u>	47
<u>Location of Nests</u>	51
<u>Nest Attentiveness</u>	51

	Page
<u>Rest Periods During Incubation</u>	52
<u>Movements of Hens With Broods</u>	53
<u>Behavior of Hens With Broods</u>	54
<u>Nest Desertion</u>	55
<u>Renesting</u>	56
Male Pheasants	58
<u>Home Range</u>	58
<u>Territories</u>	58
CONCLUSIONS AND MANAGEMENT IMPLICATIONS	61
LITERATURE CITED	63
APPENDIX	68

LIST OF TABLES

Table		Page
1	Dates of Laying of First Egg and Periods of Oestrus for Hen Pheasants	50

LIST OF APPENDIX TABLES

1	Field Battery Life (1965) E132 2.7 Volt Mercury Battery	69
2	Field Battery Life (1966) RM-1 2.7 Volt Mercury Battery	70
3	Degree of error for nesting (inactive) hens on the Rifle-Calahan Study Area	71
4	Summary of Radio-Tracking Data on 15 Adult Pheasants, Rifle-Calahan Study Area, Sanborn County, March 9 - August 13, 1965	72
5	Summary of Radio-Tracking Data on Five Adult Pheasants, Rifle-Calahan Study Area, Sanborn County, June 17 - August 15, 1966	73

LIST OF FIGURES

Figure		Page
1	Distribution of cover types on Rifle-Calahan study area	5
2	Miniature radio transmitter used to radio-mark pheasants	8
3	Portable receiver for field studies	10
4	Hand directional antenna (HDA) in operation . .	11
5	Components of stationary directional antenna (SDA)	13
6	Recording an azimuth on a radio signal	14
7	Nest and total range of hen #8-65 during early phases of the reproductive cycle - April 14 - May 17, 1965	20
8	Nest and total range of female #10-65 during early phases of the reproductive cycle - May 3 - June 2, 1965	22
9	Nest and total range of hen #11-65 during early phases of the reproductive cycle - May 3 - May 25, 1965	24
10	Nest and total range of female #12-65 during renesting, incubation and early phases of brood rearing - May 28 - July 28, 1965	26

Figure		Page
11	Nest and total range of hen #13-65 following desertion of her nest - June 1 - June 4, 1965	30
12	Nest and total range of female #14-65 during renesting, incubation and brood rearing - June 9 - July 1 and July 16 - August 13, 1965	31
13	Nest and total range of hen #15-65 during incubation and brood rearing - June 15 - July 12, 1965	35
14	Nest and total range of female #1-66 following destruction of her nest - June 17 - July 6, 1966	38
15	Crowing site and total range of male #2-66 - June 17 - July 14, 1966	40
16	Crowing site and total range of male #3-66 - June 22 - July 14, 1966	42
17	Nest and total range of hen #4-66 following desertion of her nest - June 24 - July 18, 1966	44

INTRODUCTION

The ring-necked pheasant (Phasianus colchicus) is the most economically important game bird in South Dakota. It was first introduced in the state in 1898 when Dr. A. Zitlitz released several varieties near Sioux Falls. Other releases were made by private individuals in 1903, 1908 and 1909. In 1912 the state game Department began a program of releases by issuing 200 pairs of pheasants to interested individuals. By 1918 the total released was approximately 7,000, most of which were from the Department's program (Hipschman 1959). Pheasants are common in all counties in the eastern half of the state.

Records were not kept on the growing pheasant population during the 1930's and early 40's, but an unusually high peak was reached at the close of World War II. Since the mid 1940's, the ringneck population has generally diminished although moderate increases occurred during the Soil Bank era in the late 50's and early 60's (Dahlgren 1963). South Dakota has been able to maintain an ample population to provide for liberal harvests, but the intensification of agricultural methods has dealt a serious blow to the pheasant (Christensen 1963, Dahlgren 1967).

Pheasant hunting is a multi-million dollar industry in the state as hunters, especially non-residents, add millions of dollars to the economy (Beatty 1953). With much recreational and monetary

importance placed on the pheasant, it is necessary that the complete ecology of this bird be understood.

Many workers have studied the breeding behavior of the pheasant in the wild. Bent (1932) discusses much of the work done in this country prior to that time. Wight (1945) was the first to describe the breeding habits from the view point of a game manager. Baskett (1947) made general observations of breeding season behavior of cocks. Taber (1949) and Collias and Taber (1951) examined this behavior more specifically. Dale (1956) investigated the mating and reproduction patterns of both sexes. More recently Burger (1966) made observations of the aggressive behavior of the cock during mating.

In South Dakota various studies have been conducted in relation to population census methods (Kimball 1948 and 1949 and Trautman 1966). In addition Nelson (1946 and 1948) studied population characters of the birds. Dahlgren (1963) associated population trends with adult mortality and subsequently discussed possible mechanics of the pheasant decline in the state (Dahlgren 1967). Trautman (1960) evaluated nesting habitat in eastern South Dakota. These authors added knowledge to the mechanics of pheasant management, however little emphasis has been on reproductive ecology which is of primary importance in management if the pheasant is to remain an important game bird.

In 1964 the Game Division of the South Dakota Department of Game, Fish and Parks initiated a pheasant movement and behavior

study using radio telemetry techniques. Objectives of the study were to evaluate radio telemetry techniques, determine the territorial area and home range of the hen and cock, study the behavior pattern of hen and cock in the harem makeup, determine the distance traveled by the hen when attracted to the harem, determine if the hen nests in the immediate area of the crowing territory, and study the behavior of the hen while nesting and caring for the brood.

Problems of locating marked animals have been expressed by Cottam (1956), Taber (1956), Klett (1957) and Brown (1965). Most marking techniques require direct observation or physical examination for identification. Normally physical aspects of individual animals are altered to some extent by addition of bands or tags, or by dyeing (Harris 1951, Balham and Elder 1953, and Gullion 1965). Pendleton (1956) described the use of radio isotopes as a marking device, but with that method marked individuals cannot be visually distinguished.

Biotelemetry was recently introduced as a method to study animal movements and to better understand management problems of the species. Use of radio telemetry in studies of several upland game birds were described by Marshall (1963, 1965), Marshall and Kupa (1963), Brown (1965), Kobriger (1965), Schladweiler (1965), McEwen and Brown (1966) and Brander (1967).

DESCRIPTION OF AREA

The study was conducted on the Rifle-Calahan public shooting area 26 miles southeast of Huron in Sanborn County (Township 108N, Range 60W, Sections 34, 35 and 36; and Township 107N, Range 60W, Sections 1, 2 and 3), South Dakota (Fig. 1). This 2.4-square-mile area is owned by the South Dakota Department of Game, Fish and Parks and managed for public hunting. During the study approximately 68 percent of the area was grass and haylands, 26 percent wetlands (temporary and permanent), 4 percent cultivated and 2 percent shelterbelts and abandoned farmsteads.

Located in the physiographic region known as the James Basin (Rockroth 1944), this area is a glaciated upland situated midway between the Missouri River and Minnesota border. Soils were deposited by the Wisconsin glacial ice sheet which moved down the James Valley. They are deep, dark loams to clay loams. Mild to moderate claypan spots occur in complex association with enclosed depressions (Sanborn County Agriculture, 1959).

The area was once part of the mixed grass prairie (Weaver and Clements 1938). Remnants of climax plant species scattered throughout the area are green needle grass (Stipa viridula) needle-and-thread (Stipa comata), western wheatgrass (Agropyron smithii) and slender wheatgrass (A. trachycaulum). Dominant grasses include Kentucky blue grass (Poa pratensis), smooth

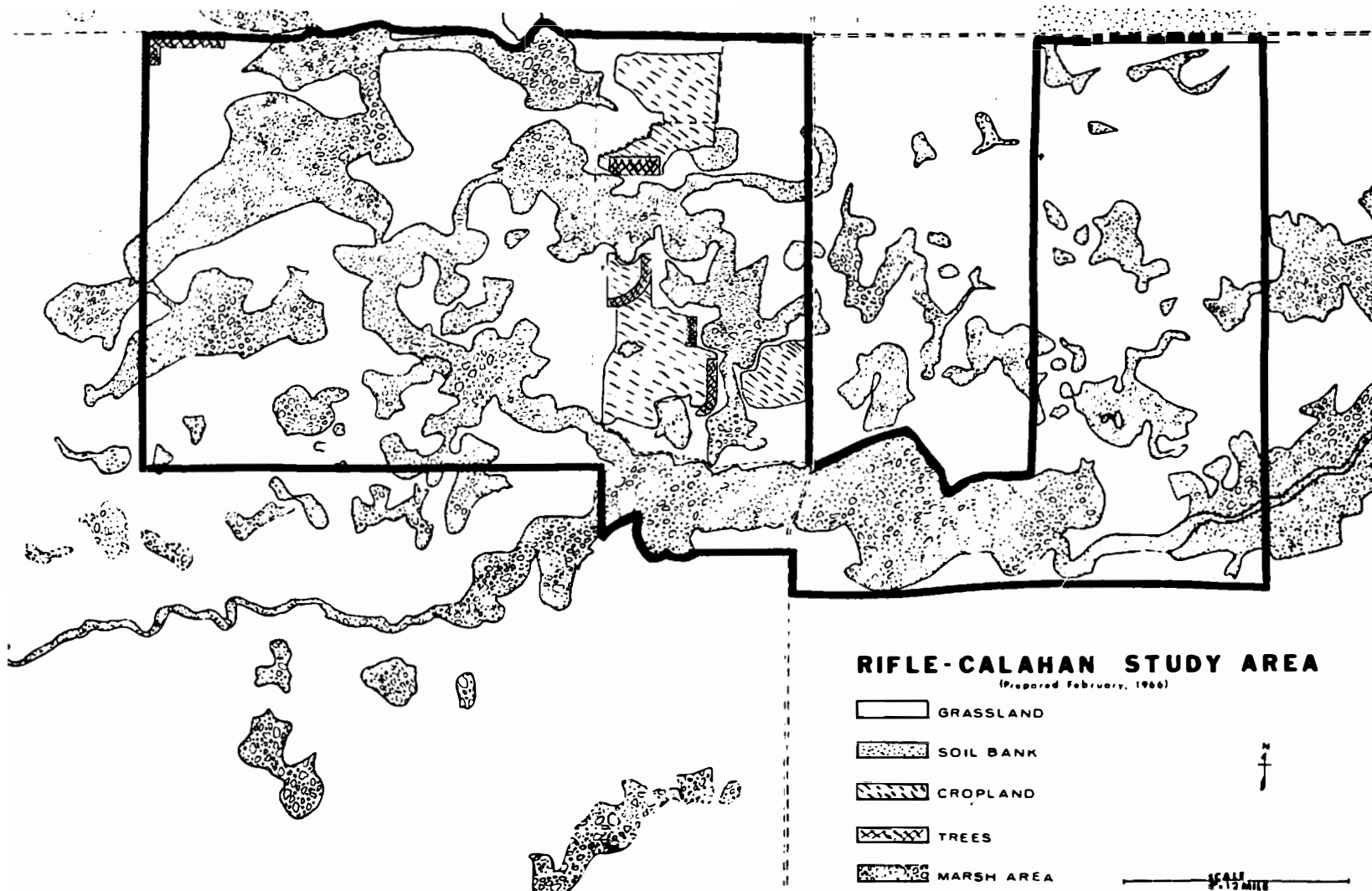


Figure 1. Distribution of cover types on Rifle-Calahan study area.

bromegrass (Bromus inermis), crested wheatgrass (A. cristatum), downy brome (Bromus tectorum) and foxtail barley (Hordeum jubatum). Also scattered throughout the area are patches of white and yellow sweetclover (Melilotus alba and M. officianale), wild sunflower (Helianthus annuus) and kochia (Kochia scoparia). Aquatic vegetation characteristic of the wetlands are river bulrush (Scirpus fluviatilis), common reed (Phragmites communis) and reed canary grass (Phalaris arundinacea). Russian olive trees (Elaeagnus angustifolia) are common throughout the area with eastern cottonwood (Populus deltoides) and willow (Salix sp.) being most abundant around the more permanent wetlands. Eastern red cedar (Juniperus virginiana), Siberian elm (Ulmus pumila) and American plum (Prunus americana) are the most common species in field shelterbelts.

Artesian wells are numerous in the region. During the study period four were flowing on the area and seven others were flowing on adjacent lands.

The climate of the region is characterized by extreme temperature fluctuations. The 24-year average annual temperature is 46 F: extremes recorded at the Forestburg station (13 miles southwest) are -46 F (1899) and 116 F (1936). Annual precipitation is 20-22 inches with 70 percent falling during the growing season (April-September). This climate favors production of small grains, row crops and forage. According to the 1956 farm census, corn, oats and alfalfa hay comprised over 90 percent of the crops produced (Sanborn County Agriculture 1959).

METHODS AND MATERIALS

Capture Techniques

A modification of the funnel trap described by Gullion (1965) was used to capture pheasants during winter months of 1965. Two cocks were captured during the summer of 1966 using a decoy trap similar to that described by Rogers (1964). Night-lighting capture techniques (Labisky 1959) were only partially successful following the spring dispersal of 1965. During the 1966 study period a backpack night-lighting unit (Drewien et al. 1967) proved to be a successful method of capturing birds. In addition incubating females were caught on their nests with long handled landing nets during both periods of the study.

Marking Devices

All radio-equipped birds were banded with colored leg bands similar to those used by Gullion (1965) and Jackson (1967). Saflag, a colored fluorescent material (Safety Flag Co. of America, Box 1005, Pawtucket, Rhode Island), was used as a colored leg streamer on all radio-marked birds.

Twenty adult pheasants were marked with a miniature radio transmitter (Fig. 2).

The harnessing technique described by Marshall (1963) and Schladweiler (1965) was modified by the development of a battery

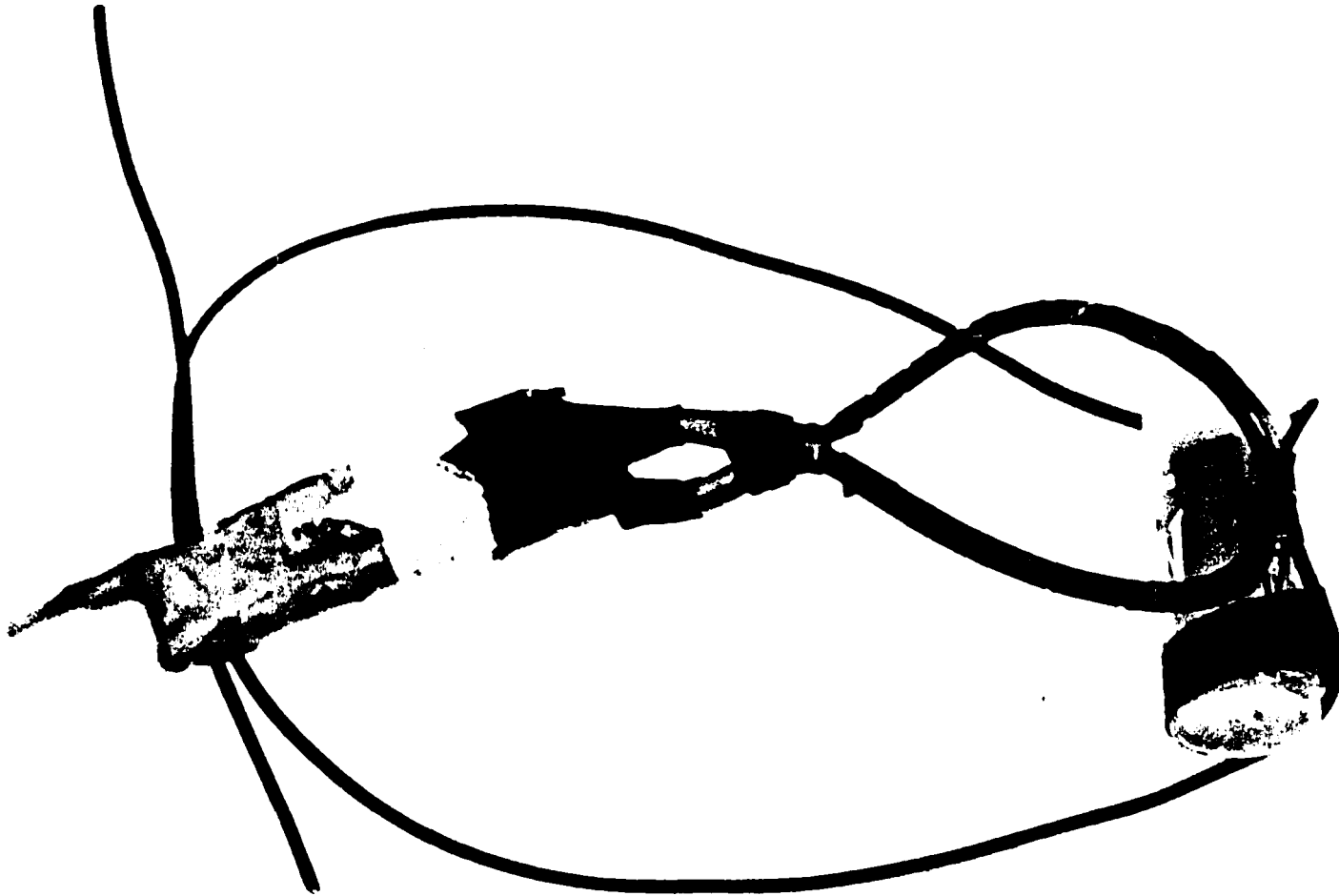


Figure 2. Miniature radio transmitter used to radio-mark pheasants.

hookup which eliminated direct soldering on the battery and allowed for rapid instrumentation in the field (Kuck 1966). A second set of leads served as the harness.

Locating Marked Birds

Radio signals were received with a portable receiver produced by Sidney Markusen of Cloquet, Minnesota which has discrete channels allowing simultaneous study of six radioed individuals (Fig. 3).

A hand directional antenna (HDA) and a stationary directional antenna (SDA) were used for receiving signals. The HDA, used in searching out and flushing marked birds, consisted of a 36-inch section of aluminum tubing and two 30-inch wire cross elements (Fig. 4). When swung in an arc it enabled the investigator to locate birds for close observation or capture.

The SDA's were semi-permanent and used to determine locations of marked individuals. Care was taken when an SDA location was selected as access, good elevation and the view of permanent landmarks legible on the base map was of primary importance. Slade et al. (1965) indicated higher elevations of their study area were best for receiving radio signals.

In erecting the antenna a 20X spotting scope was used to align the antenna mast with visible landmarks. The yagi was pointed directly at the landmark so all elements were directly in line; the angle was then recorded. This procedure was followed for aligning

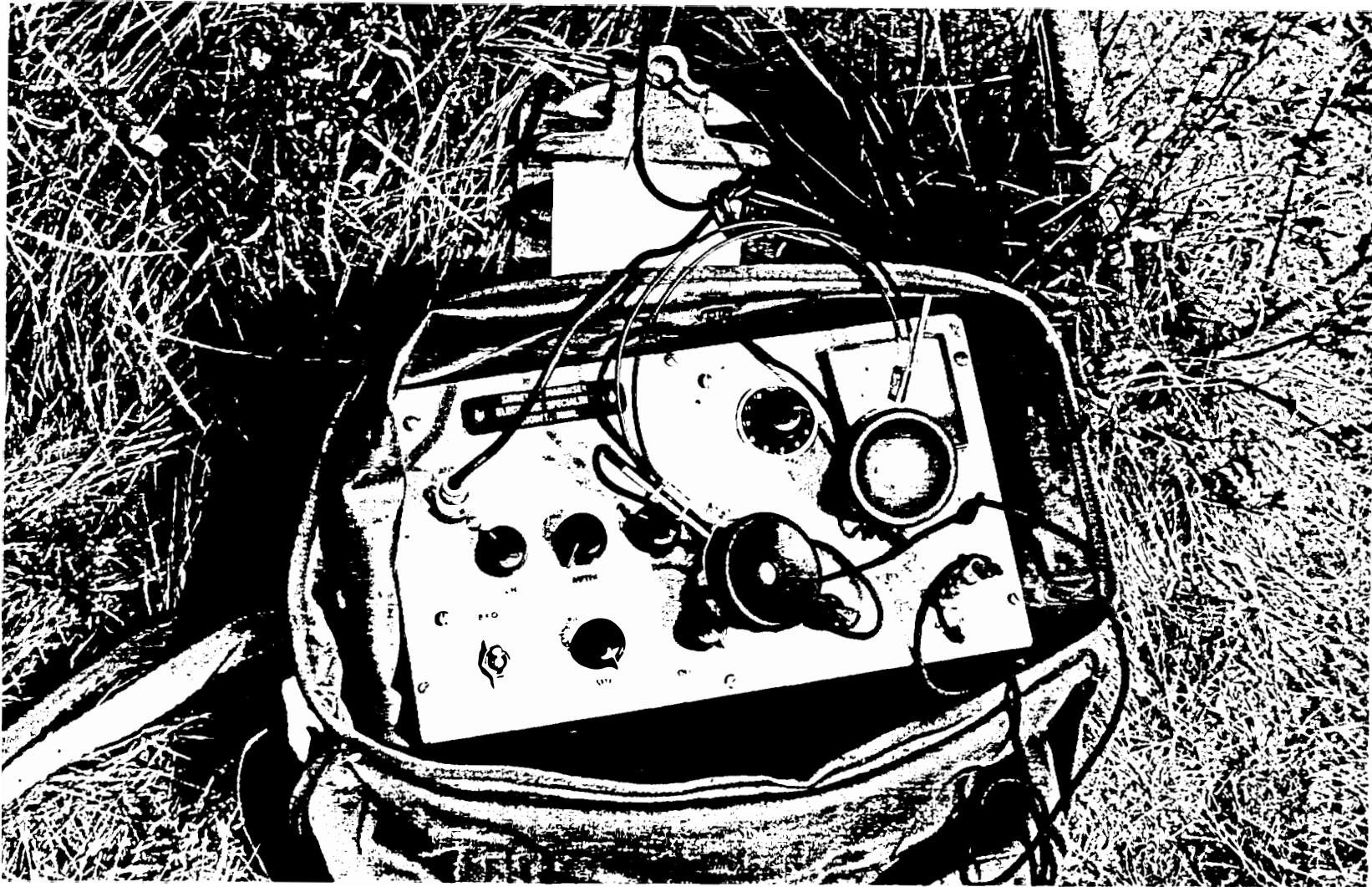


Figure 3. Portable receiver for field studies.



Figure 4. Hand directional antenna (HDA) in operation.

the SDA on a second landmark. These resulting compass readings were then used to locate the SDA position on the base map. To assure precise alignment, this procedure was repeated for each SDA twice weekly throughout the duration of the study.

In locating an instrumented bird an azimuth was taken on the radio signal from two different SDA's and intersects of the azimuths was considered the location of the bird. Details of the procedure used in determining azimuths was described by Slade et al. (1965).

Components of an SDA included a base, compass plate, mast sections in 10 foot lengths and a yagi (Fig. 5). The mast consisted of 10 foot sections of 1 3/4 inch conduit. Mounted horizontally on the mast was a 10 foot, 8 element yagi made of 3/4 inch thin wall electrical tubing. The elements were the same as those on TV antennae but cut to receive desired frequency. The mast was inserted in a TV stand staked to the ground. A handle fastened to the mast 18-inches from the stand top facilitated complete rotation within the stand. A 10-inch diameter compass plate marked at five degree intervals was bolted to the stand. The yagi direction (azimuth) was read by a compass needle or indicator attached to the mast (Fig. 6). The antenna was guyed and rotated within a guy ring resting on a ring clamp 18-inches from the mast top.

Field Battery Life

The length of time a transmitter battery will supply sufficient power to produce an audible signal is known as "field battery life"

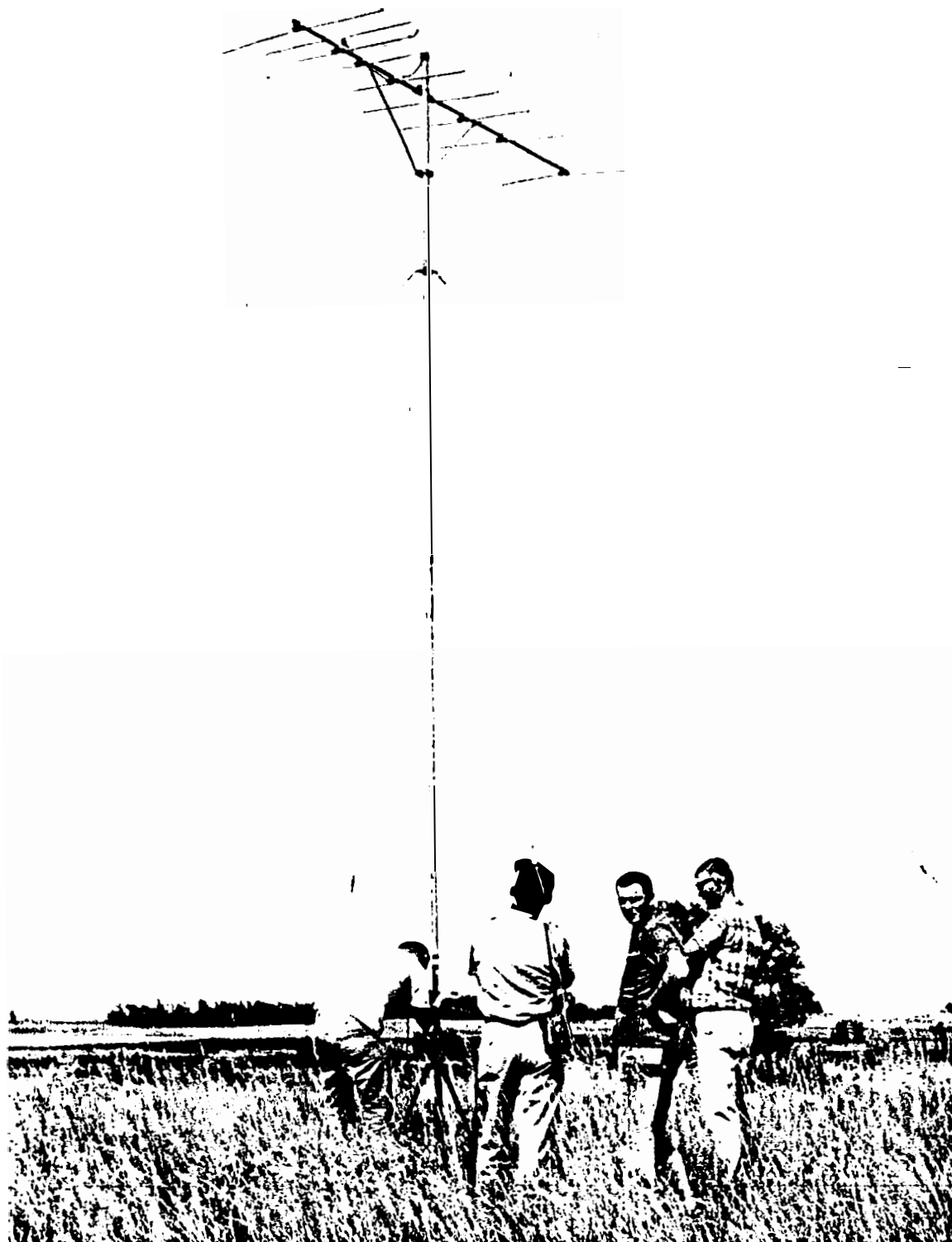


Figure 5. Components of stationary directional antenna (SDA).



Figure 6. Recording an azimuth on a radio signal.

(Schladweiler 1965). Two different mercury batteries were used to power the transmitters: Eveready E132 during 1965; Mallory RM-1 during 1966. Both batteries were the same in size, shape and weight. The E132 provided a maximum life of 33 days when used in the field as compared to 27 days for the RM-1.

The calculated battery life and the empirical life in a heated room were found to be somewhat higher than that experienced on a monitored pheasant in the field. Schladweiler (1965) also found this disparity in his study of ruffed grouse. The calculated life is rated under conditions not experienced in the field.

At the onset of the study battery leads were soldered to the battery but later discovery that heat from soldering apparently decreased battery life prompted development of the new battery hookup previously noted. This hookup was not used on the first seven monitored pheasants. Records of field battery life are given in Appendix Tables 1 and 2.

RESULTS

System Error

The angle between the system-determined bearing and the true bearing of the animal is known as system error (Heezen and Tester 1967). The error may be caused by several sources which include antenna alignment, inaccurate positioning of antenna on the base map, battery strength, weather, bird movement, operator experience and fatigue. Marshall (1963) described many of these in addition to others as causes or errors in his system of bird location. Heezen and Tester (1967) and Cochran et al. (1965) also mentioned a reading error which occurs while a bird location is made or while plotting the location on the base map.

It was virtually impossible to determine the system's error from readings on an active bird for the pheasant, being wary, generally will not remain stationary long enough so location can be made with the HDA after an azimuth has been taken with the SDA. An attempt to determine the accuracy of the system was made with known nesting sites of monitored birds. Accuracy of the system was not checked in the manner which Marshall (1963) and Slade et al. (1965) tested their systems. Objectives of this study were to make telemetry observations on pheasants general movement and behavior, and therefore, accuracy of triangulation was not stressed. These feelings are also expressed by Heezen and Tester (1967).

System error was determined as follows: After precise alignment of the SDA with visible landmarks the yagi was pointed at the nesting site. The investigator, standing directly on the site of the nest, used a 20X spotting scope to confirm the yagi was pointed directly at him and that all elements were in line. The azimuth was then read and compared with those recorded while the monitored bird was nesting. This procedure was carried out on three nesting sites with two stationary antennae sighted in on each (Appendix Table 3). The accuracy was somewhat similar to that noted by Marshall (1963) and Slade et al. (1965).

Reactions of Birds to Transmitters

All pheasants monitored reacted in an apparently normal manner. In some cases, immediately after release, the birds experienced difficulty in flying, or appeared to be in shock. This was likely due to handling and strangeness of the transmitter package, but was overcome once the bird adjusted to the apparatus. Marshall (1963) reported that three ruffed grouse reacted abnormally when monitored and were unable to carry the transmitter.

The transmitter did not appear to disturb mating activities as a cock was observed copulating with an instrumented hen and a second cock was seen to vigorously pursue another instrumented hen. In two cases cocks continued their crowing activities after being instrumented. Two hens which carried the radio package prior to

nesting brought off complete clutches. Three other radio-marked hens were observed in harems or responding to crowing cocks. All three hens nested but failed in their first attempt to bring off a brood and either their signal was lost or the hen was killed before renesting was attempted.

Examination of birds which were retrieved after carrying the transmitter for varying lengths of time indicated that a proper harness fitting produced no abrasion on the bird. Wear on the transmitter was negligible. This is in agreement with Schladweiler (1965).

Interpretation of Pheasant Activity

In addition to radio location the transmitters also revealed activities of pheasants. When a bird moved, a signal change resulted as the antenna began "whipping" and caused the signal pitch to modify. It was possible to determine whether the pheasant was stationary, walking, flying, feeding, dusting or crowing. Marshall and Kupa (1963) and Schladweiler (1965) indicated that these interpretations of activities for ruffed grouse were possible and Brown (1965) was able to distinguish these in his study of sharp-tailed grouse. McEwen and Brown (1966), while studying the effects of pesticides on breeding sharptails using telemetry techniques, found in addition to normal activities they could also interpret activities resulting from the effects of pesticides (convulsions, head nodding, respiration).

Movement and Behavior Determined By Radio Location

Fifteen adult pheasants (13 hens and 2 cocks) were outfitted with radios and studied from March 9 through August 13, 1965. These provided 307 total tracking days and 1235 locations (Appendix Table 4). Five additional adult pheasants (3 hens and 2 cocks) were radio-marked in 1966 and provided an additional 112 total tracking days and 109 locations (Appendix Table 5).

Movements and behavior of radio-marked individuals are presented on the basis of some annual activities. For the females these are prenesting, nesting, incubation, nest desertion or destruction, renesting, brood rearing and after abandoning or losing the brood. For males, crowing behavior and movement of two adults are presented. Histories of individual birds follow in the order which the birds were monitored.

Bird #8-65.—This female, instrumented on the night of April 14, remained in almost the exact location of her release until April 16 at which time she moved approximately one mile northeast into a private 40-acre idle-acre field adjacent to the study area (Fig. 7). The field vegetation was primarily green and yellow foxtail (Sctaria viridis and S. lutescens) with a sparse stand of alfalfa (Medicago sativa) and patches of kochia (Kochia scoparia). This composition appeared to be favored for nesting as the hen density in this field was approximately one per acre. During the 33 days which #8-65 was tracked, the bird spent 32 days in the westerly half of the field.

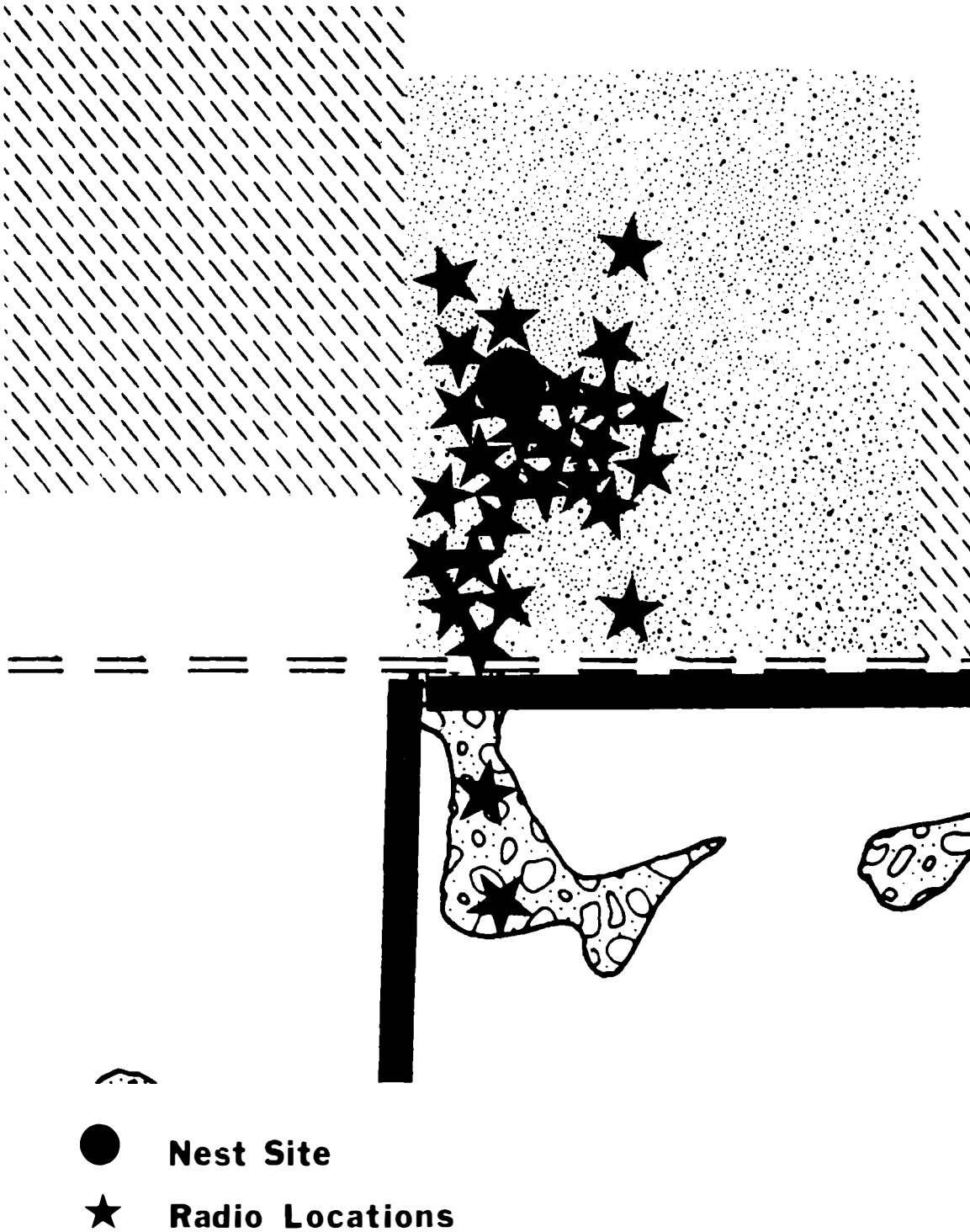


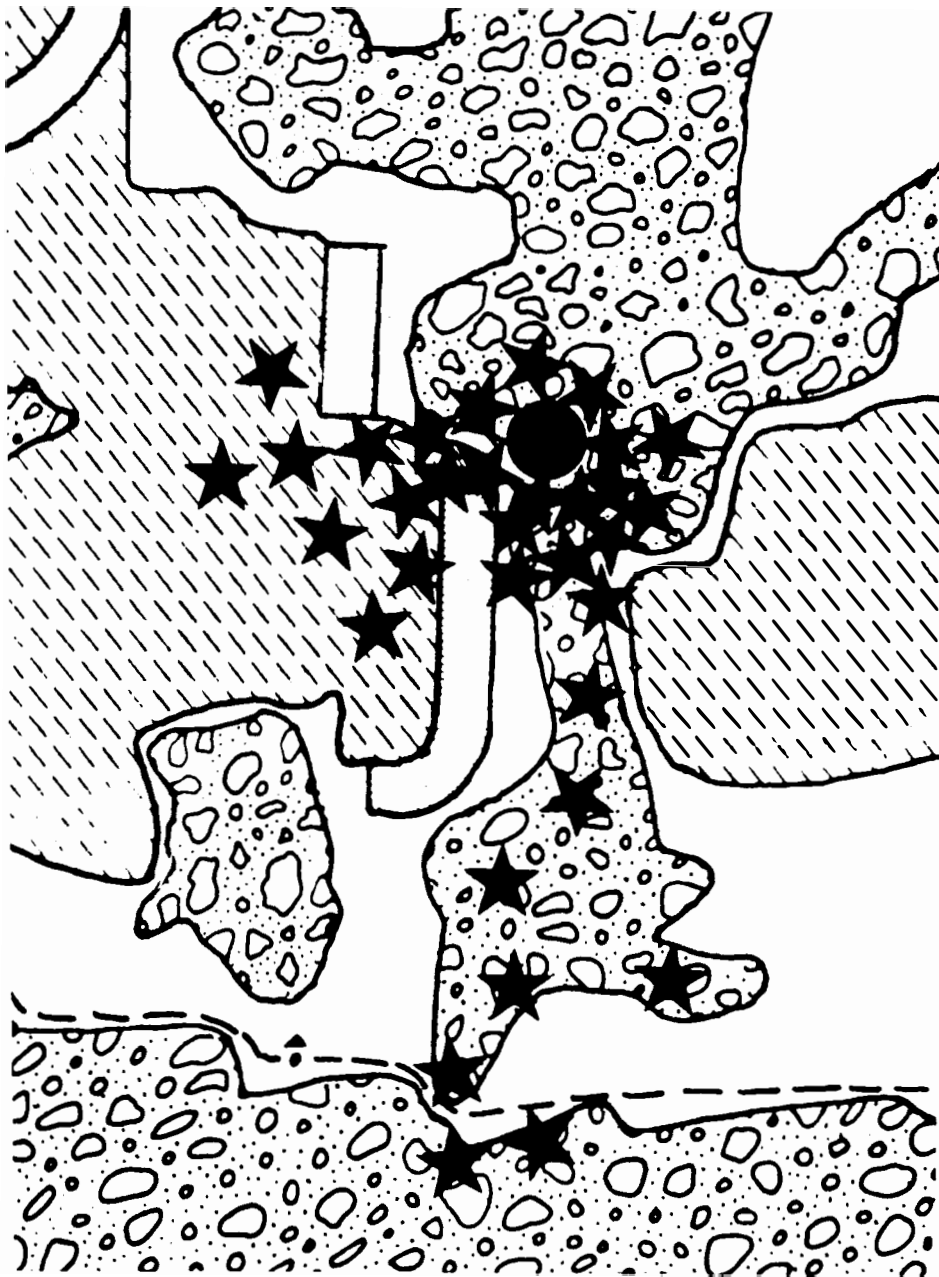
Figure 7. Nest and total range of hen #8-65 during early phases of the reproductive cycle - April 14 - May 17, 1965.

On May 8 she was in a harem with 11 other females, and on May 10 she was observed in copulation with a cock.

During the next 6-day period her movements and activities were followed closely with the HDA. She began spending considerable time in the same area and I suspected she was nesting. The area was carefully searched on May 12 and a nest containing eight eggs was found. On the morning of May 15 radio signals from the hen indicated she was inactive on or near the nest. It is possible that she had begun incubating then. On the next day the field was harrowed and reseeded to reestablish the alfalfa stand. The nest then containing 12 eggs was destroyed, as were six other active nests which were under observation. Following the destruction of her nest the signal was lost and she was not seen or heard again.

Bird #10-65.—This female, captured and monitored on May 3, remained in the vicinity of capture and occupied approximately 24 acres (Fig. 8). Most of her activities were in a Type 3 marsh, although she fed frequently in a newly-sprouted oats field. On several occasions she moved close to two other monitored females. She was among 10 or more hens in a harem on May 13 and on May 17 she was vigorously pursued by the cock on his crowing territory. Copulation was not witnessed at this time although, from the behavior of the cock, it probably occurred.

Since May 11 the hen had been suspected of nesting, however, continued searches of phragmites and river bulrush (Scirpus



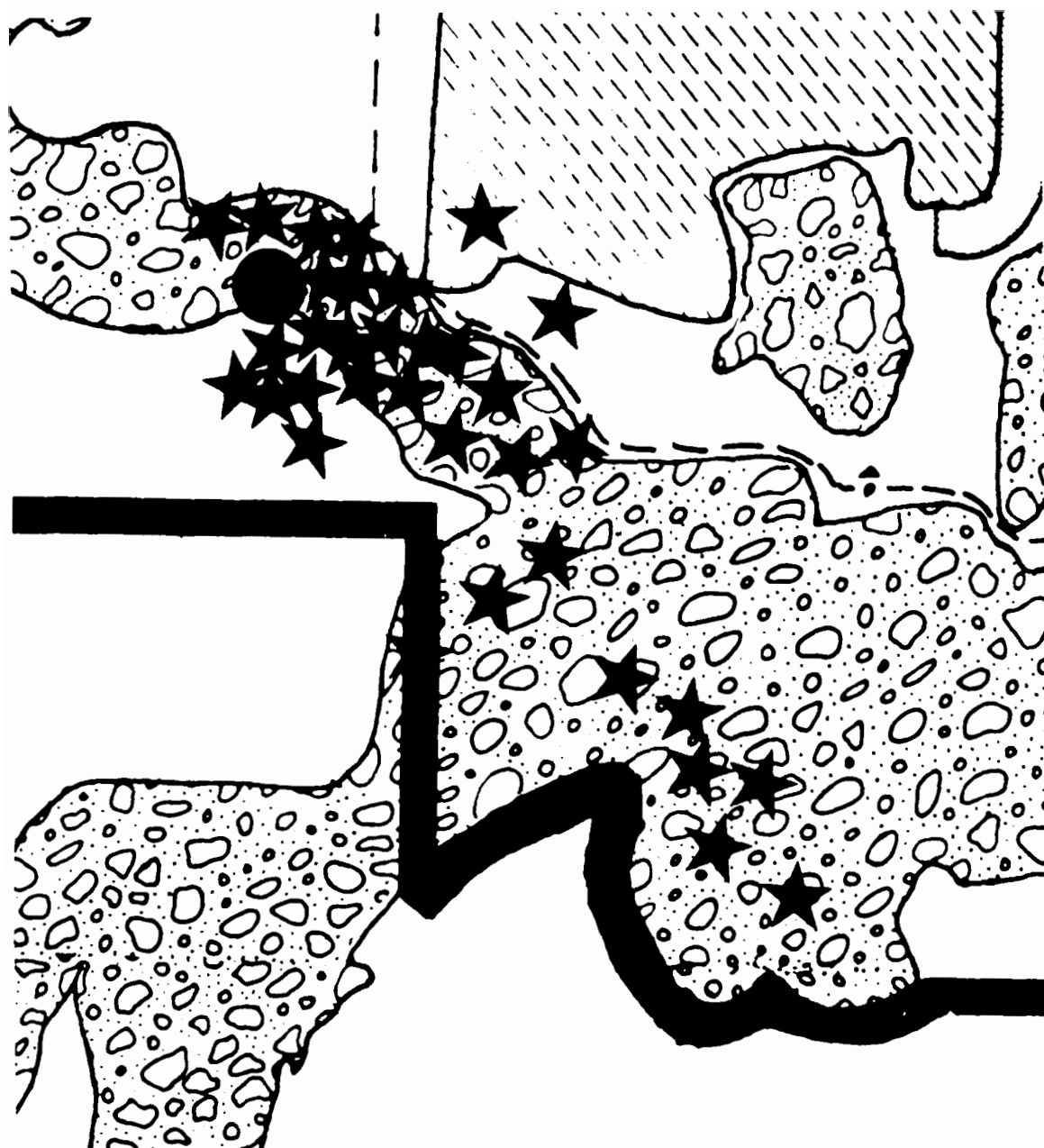
- Nest Site
- ★ Radio Locations

Figure 8. Nest and total range of female #10-65 during early phases of the reproductive cycle - May 3 - June 2, 1965.

fluvialus) where she was located on several occasions, failed to reveal a nest until May 25. The nest containing nine eggs was in thick phragmites. Her signal began to weaken on May 27 so she was captured and her transmitter exchanged. She possessed a large brood patch at this time. She was returned to the area she had occupied prior to her capture, but did not return to the area where she was thought to be nesting. Her movements for the next two days were minimal and it became apparent she had abandoned her nesting. She had not re-entered the harem or given any indication of a re-nesting attempt when her signal was lost on June 2.

Bird #11-65.—On May 3 this hen was night-lighted in a Type 3 wetland (Fig. 9). Following her instrumentation she occupied a long, 20-acre portion of another narrow Type 3 wetland. On May 10 she was frequenting an area where a cock was actively crowing. The rapid, wavering signal received and behavior of the cock on the crowing territory led me to believe that copulation was effected.

Close observation during the next three days indicated she was nesting. Daily searches of heavy river bulrush where she was suspected of nesting did not reveal a nest until May 18, when a nest containing nine eggs was found. Another egg was added the following day. Heavy rains on the area prevented any intensive study of this bird during the next four days but signals indicated she was on the nest when checks were made. On May 24, a weak, steady signal was received from the vicinity of the nest. No



Nest Site



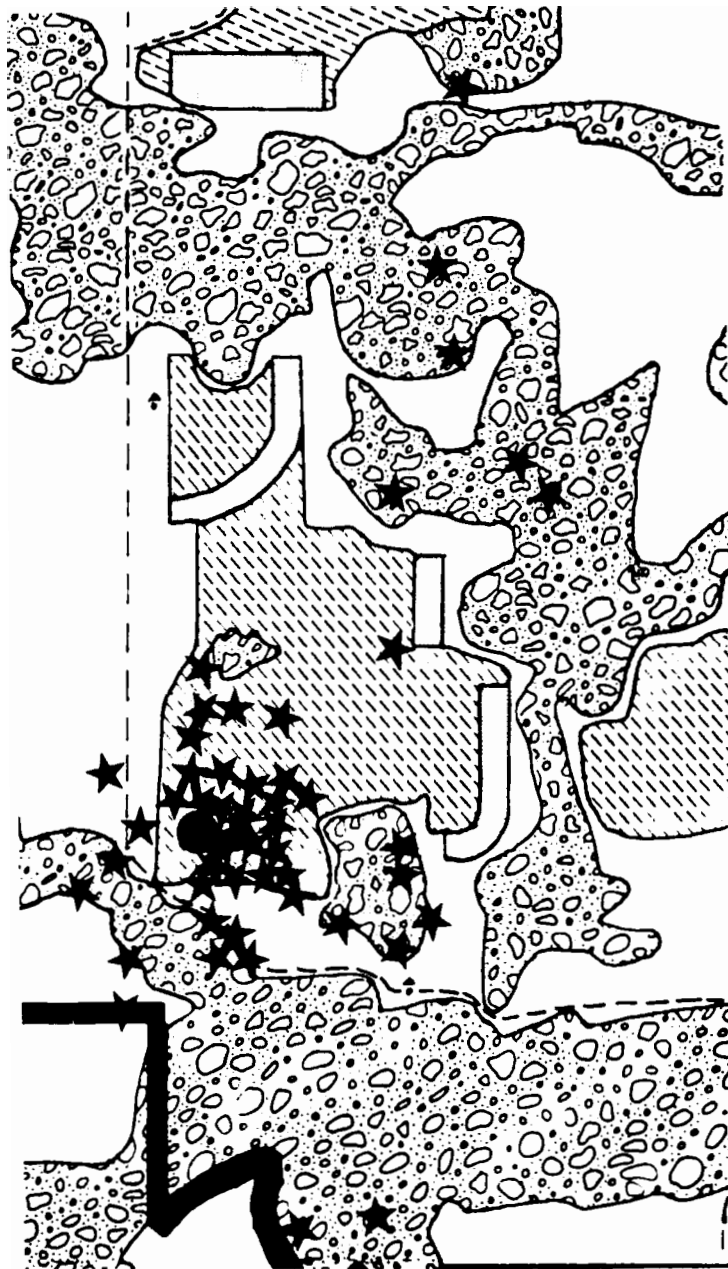
Radio Locations

Figure 9. Nest and total range of hen #11-65 during early phases of the reproductive cycle - May 3 - May 25, 1965.

signal could be received with the SDA on May 25. A check on the nest revealed seven of ten eggs were broken. Remains of the hen were located with the HDA about 20 yards from the nest. The transmitter, torn from the bird and found close by, still emitted a weak signal. The bird had apparently been killed by a mammalian predator the night before. Flesh on the carcass was still fresh. Teeth marks on the transmitter were probably those of a fox.

Bird #12-65.-This hen, night-lighted and radio-equipped on May 28, appeared to be in shock at the time of her capture, but otherwise was in good condition (Fig.10). She possessed a large brood patch. On May 29 the area was checked and a nest containing 10 or more eggs was found near the spot of her capture. The nest had been destroyed by the vehicle used for night-lighting. The hen likely fled from the nest before the vehicle passed over it.

Her movements for the next three days were in an area of approximately 14 acres. On June 3 she moved over one-half mile north of her previous location. This long movement was assumed to be in response to a crowing cock. She was not known to return to the crowing area of this cock again. By 4:00 p.m. on this date she returned to the area she occupied since being monitored. On June 9 and again on June 12 she was responding to a crowing cock on the territory where #11-65 had responded. The hen had by this date confined her main activities to an area of approximately four acres, and it was quite apparent she was renesting.



● Nest Site
★ Radio Locations

Figure 10. Nest and total range of female #12-65 during renesting, incubation and early phases of brood rearing - May 28 - July 28, 1965.

Her nest of eight eggs was found on June 21 in an alfalfa field. It had been apparent for some time that the hen had renested and was now incubating, but fearing the hen might abandon her nest, earlier attempts to find the nest were not made. An egg was broken open to determine when incubation had begun. Back dating from June 18, (the apparent onset of incubation) and using 1.25 days per egg as the average rate of laying, June 8 was the date this hen began renesting.

During the egg laying period it was noted the hen continued to occupy the same area which she had used earlier. She was on the nest at 2 p.m. and took only 45 minutes while laying her first egg, but spent some 6½ hours on the nest one afternoon while laying the final egg.

During incubation she was known to leave her nest on her own accord only once during the period from sunrise to noon. In all other observation periods she left the nest in the afternoon between 2:30 and 5:00 p.m. In final stages of incubation her active period came later in the day, with 5:00 p.m. being most common. The average active period for this hen ranged from 1 to 2 hours. Her feeding activities were confined to the same four acres she occupied prior to renesting and during the egg laying period.

On July 11, 44 days after losing her previous nest, the bird brought off a brood of six chicks. The remaining egg was infertile.

She tended her brood in an area of about three acres near the nesting site during the seven days following their hatch.

The alfalfa field the hen and brood were occupying was mowed on July 17. Readings taken on the morning of this date showed they were near the nest site. On July 19, the hen moved into a Type 3 marsh approximately 1300 feet southwest of her July 17 location. She was active only twice during the day, both periods being in late afternoon. When the area of the nest was searched one decapitated chick was found about 50 yards from the nest site. The chick, about a week old, was presumed to have belonged to the monitored hen.

Locations on July 20 revealed her travels had brought her back to the alfalfa field although she was not showing much activity. She was tracked with the HDA and forced to fly. None of the brood was observed with the hen at this time. She flew northeast approximately 1300 feet and came to rest in a Type 3 marsh where she remained inactive for the remainder of the day.

On July 21 the signal of this hen began to weaken and she was captured and her transmitter replaced. It was found that all the toes on both feet had been cut off when the alfalfa was mowed. She was in very poor condition, but the transmitter was left on to determine her subsequent activity.

A check on the area where she was located on the morning of July 17 revealed four more decapitated chicks. This accounted for five of the original six, all within 75-150 feet of the nest.

After the transmitters were changed the hen remained in the marsh where she had flown following her release. She was inactive for the next six days and on July 28 was found dead. It appeared she had been dead for about 48 hours.

Bird #13-65.-This hen was captured on her nest on June 1 and was in her third day of incubating a clutch of 13 eggs (Fig. 11). The bird was color banded, monitored and returned to her nest where she remained for nearly an hour before deserting. She moved approximately 1300 feet northeast to dense river bulrush in a Type 3 marsh, then remained in this location until June 4 when her signal was lost. During the short period of radio-tracking she was active only twice when I pursued her with the HDA. Both times she moved off through the vegetation but did not flush.

Bird #14-65.-This female, captured while incubating a clutch of nine eggs on June 9, was in her ninth day of incubation (Fig. 12). Although she was placed on her nest after being monitored and color marked with an orange leg streamer, she promptly deserted.

After deserting she moved into a Type 3 marsh and confined her main activities to 10-acres. On the morning of June 14 when she was noted responding to a crowing cock, her location was approximately 1800 feet northeast of the previous location. On the evening of June 15 the hen was in the harem with two other females. Her active range had expanded to approximately 38 acres. Indications were that the hen was now reneesting.

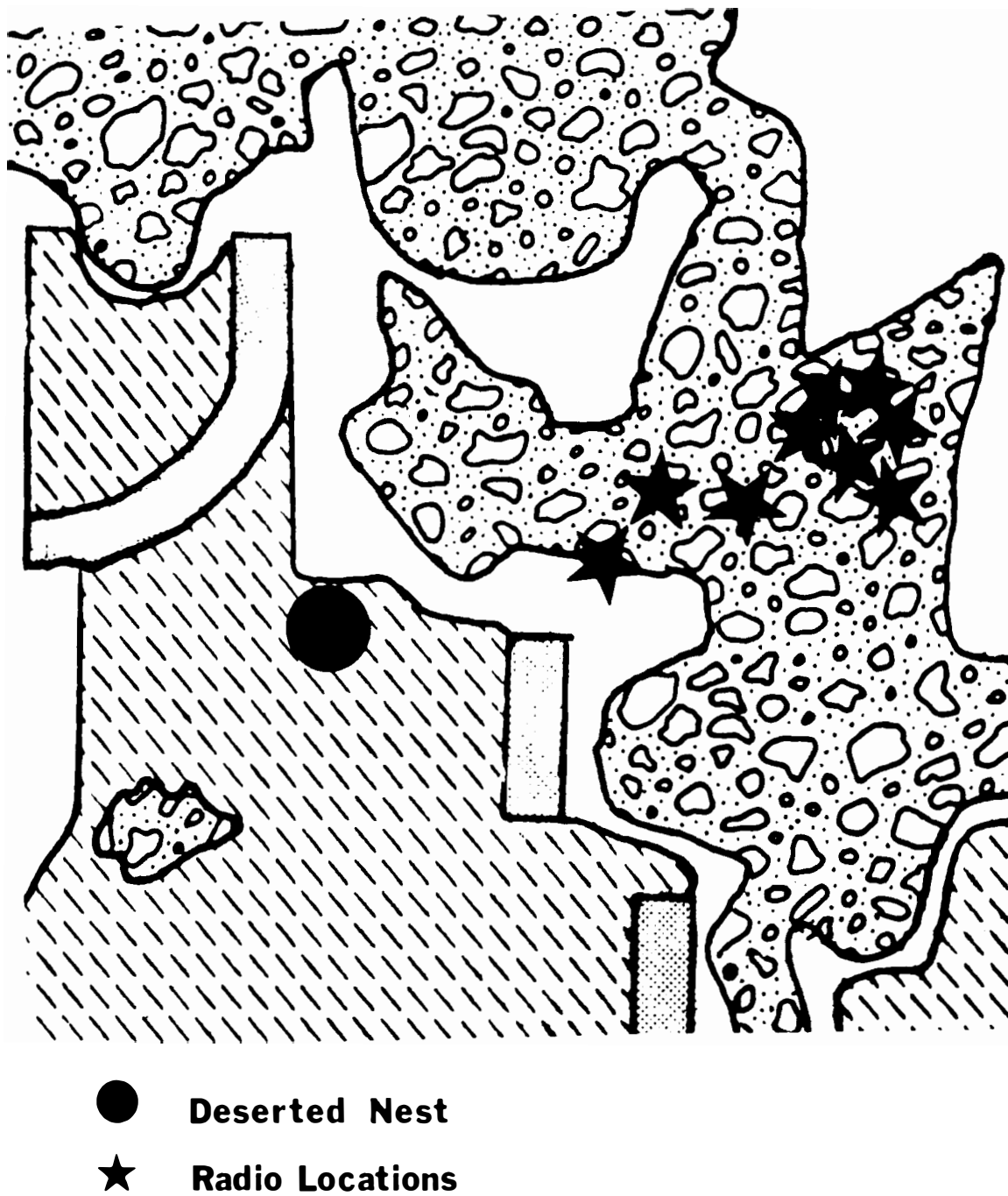
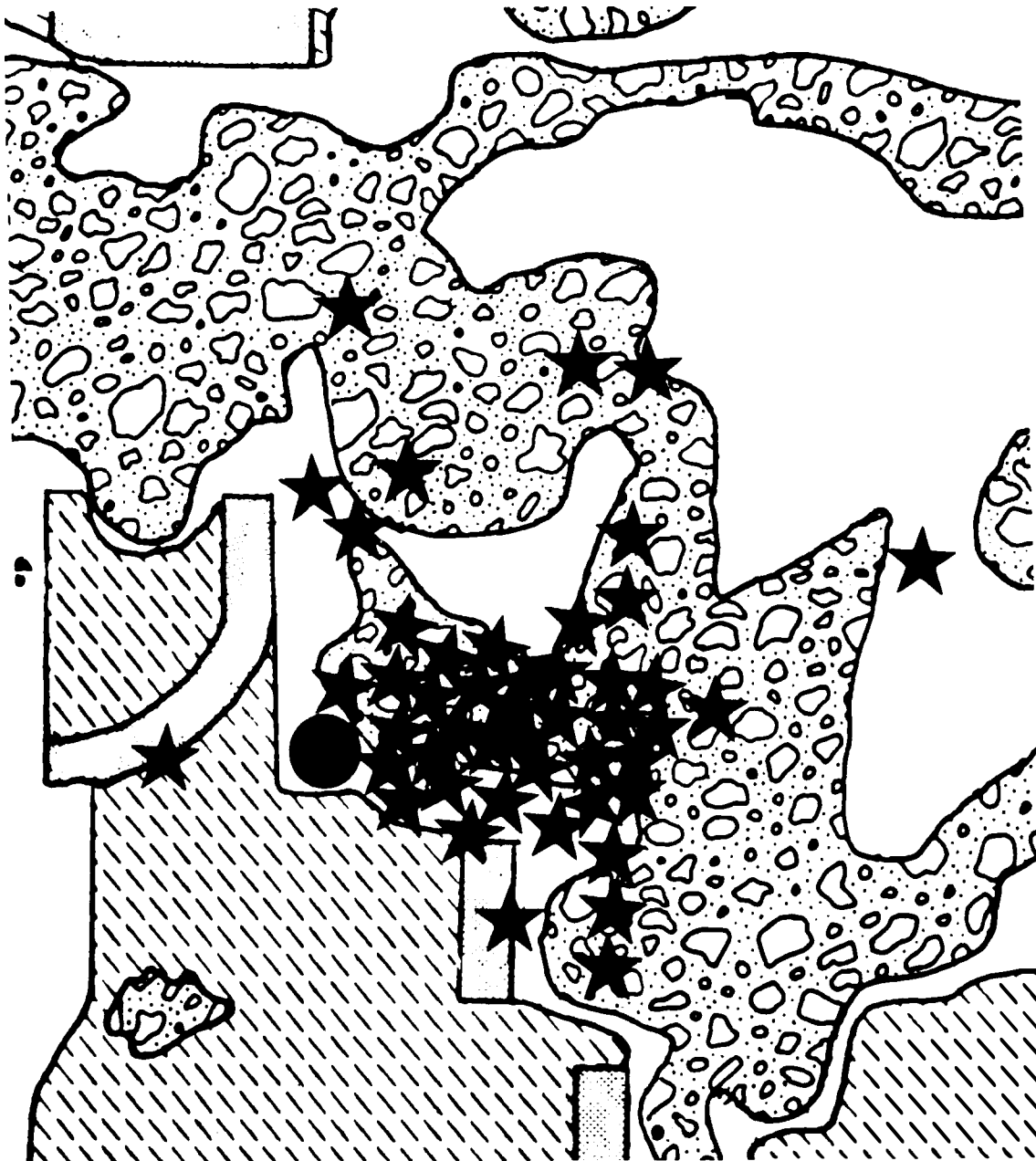


Figure 11. Nest and total range of hen #13-65 following desertion of her nest - June 1 - June 4, 1965.



Nest Site



Radio Locations

Figure 12. Nest and total range of female #14-65 during renesting, incubation and brood rearing - June 9 - July 1 and July 16 - August 13, 1965.

Movements and activities were closely monitored from the first indication that she might be renesting. Her location was marked with the HDA on June 23 and after the hen had left the vicinity of the suspected nesting site the area was checked and a nest containing five eggs was located. She had selected a patch of river bulrush on the edge of the Type 3 marsh.

Assuming pheasants lay at the rate of 1.25 days per egg, this hen would have begun renesting June 18. However, locations made on the bird every hour from 7:00 a.m. until 4:30 p.m. on this date showed she was active during the entire day. On June 19, the first date this bird was noted to be inactive, she remained near the renesting site. By June 26 a clutch of eight eggs was completed. This would indicate eggs were laid at a rate of one per day. Incubation began on June 27.

While laying, this hen was on her nest only one hour during the dropping of the first egg, but spent $4\frac{1}{2}$ hours while laying the seventh egg and $6\frac{1}{2}$ hours for the eighth egg. She was always on the nest by 12:30 p.m.

Little information was acquired from this hen while incubating as she carried the transmitter only nine days. Her transmitter began emitting a faulty signal while in her fifth incubating day and she was netted and the transmitter removed. She returned to her nest, continued to incubate and was remonitored on July 16. She again returned to incubating.

From July 16 to July 20 she was active several times during the day, often spending only one hour at a time on the nest. This did not hold true for the first five days of incubation as she was active only after 3:30 p.m. On three of these five days she did not leave the nest until 5:00 p.m.

The eggs began pipping on July 19. On this date she was off the nest until 2:30 p.m. The next day when the nest was checked at 10:30 a.m. six chicks were found completely dried. The seventh egg was pipped but the chick failed to break out. The hen returned to the nest at 11:30 a.m. and left with the brood.

It should be noted that when this hen was captured on July 1 to retrieve the faulty transmitter, an egg was cracked as the hen scuffled on the nest. This cracked egg was left in the nest and when the bird was recaptured on July 16, only seven eggs remained.

The hen's movement with the brood were very limited during the first two weeks of rearing and were confined to the vicinity of the nest. Marsh cover was most widely used. This was the same area the hen had occupied since being monitored. On a few occasions the hen brought the brood into oats stubble or to a new tree planting to feed. For the most part all activities were in the wetland.

At three to four weeks of age the brood was using an area of 26 acres; however, their movements were still within 300 to 600

feet of the nest. On August 13 when I attempted to net the hen to remove the transmitter, the bird displayed movements typical of a brooding hen. She often circled and doubled back, but always moved away from the brood. When flushed she flew only 10 or 15 yards. After the transmitter was removed she was released near her brood, about 300 feet from the nest site.

Nearly a year later on June 1, 1966, while making a reconnaissance of the area, the foot of this hen bearing the orange leg streamer was found near an old, abandoned burrow on the west side of the marsh where she had carried on her activities.

Bird #15-65.-Hen #15-65 was netted on her nest in alfalfa on June 15 (Fig. 13). She was in her 15th day incubating a clutch of 12 eggs. The hen had not returned to the nest by evening but was on the nest when checked at 7:30 a.m. the following day.

This hen was active for short periods in both the morning and afternoon during incubation. Her periods of activity occurred between 9:30 and 11:00 a.m., and between 2:00 and 4:00 p.m., and lasted about one hour. Both morning and afternoon periods of activeness came later in the day as the incubation progressed.

Two of the 11 eggs were pipped on June 24. At 10:30 a.m. the following day when the nest was checked 9 of the 11 eggs were pipped. In mid-morning on June 26 all 11 chicks were free of their shell and partially dried. The hen was active near the nest and flushed when approached. The chicks darted for cover at the



- Nest Site
- ★ Radio Locations

Figure 13. Nest and total range of hen #15-65 during incubation and brood rearing June 15 - July 12, 1965.

warning from the hen. Within 30 minutes the hen had regathered the chicks and was brooding them on the nest. Shortly after 1:30 p.m. she led the them from the nest.

Movements with the brood covered an area of approximately 10 acres during the 14 days they were monitored. Most of the activities were carried on in the alfalfa field where the brood was hatched but an adjacent unharvested oats field was also used.

The hen and brood began their activities about one half hour after sunrise. Movements for the first half hour were very slight as they moved from the damp cover into open areas to be warmed and dried by the sun. Within one to two hours after sunrise the hen moved the brood back into the heavier cover to feed and loaf.

There did not seem to be a definite pattern of activities for afternoon movement. A mid-day rest period sometimes occurred between 12:30 and 2:00 p.m. This seemed to be somewhat governed by temperature. On cool or mild days these inactive or loafing periods were not as prominent. On most evenings the brood was active until darkness.

On the morning of June 9 the hen and brood were feeding in a newly-prepared tree planting about 400 feet northeast of the nest. Upon my approach the hen sneaked off into marsh cover and the chicks fled into heavy cover nearby. The hen was captured and her battery replaced. Upon release she flew back towards the area

where she had left the brood and landed about 300 feet northeast. She remained in this spot throughout the rest of the day. A brood of 11 chicks two weeks of age was spotted within 30 feet of the nest later in the day. They were presumed to belong to the released hen.

The hen's location had not changed on the following day and she continued to show little movement. On June 12 her signal was picked up $1\frac{1}{2}$ miles to the east of the study area where she was alone in another alfalfa field. Fearing that she may move farther from the study area, she was captured, her transmitter was recovered and she was then released.

Bird #1-66.-At the time this female was night-lighted on June 17 she was incubating 12 eggs, eight of which were accidentally broken (Fig. 14). The broken eggs were removed from the nest in hopes the hen would return. They had been incubated 18-20 days.

No signal was received from hen when checked on June 20. The nest was checked and the four remaining eggs had been destroyed. From egg shell remains and the appearance of the nest it is likely a raccoon (Procyon lotor) was responsible for its destruction. On June 22 five days after instrumentation, her signal was again received and her location was $1\frac{1}{4}$ miles south of the study area. The bird remained in an oats field in this vicinity for the greater part of the day and by late afternoon started back to the study area. Upon returning she was located several times in a field adjacent

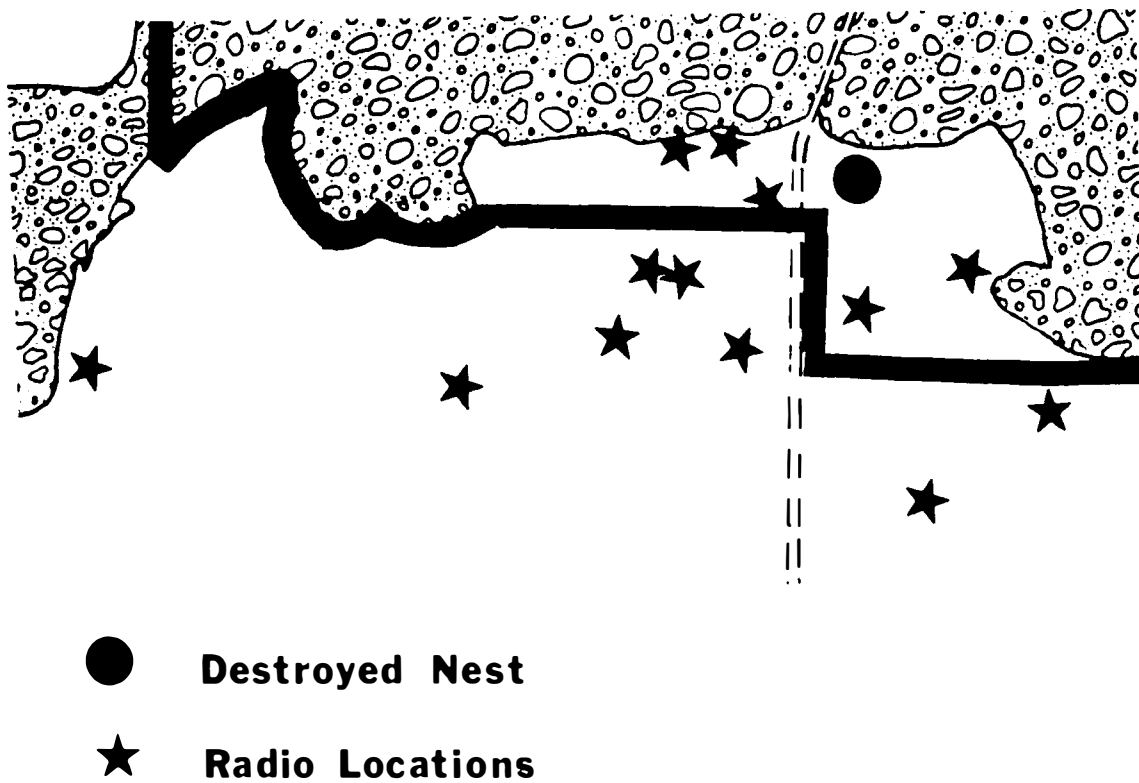


Figure 14. Nest and total range of female #1-66 following destruction of her nest - June 17 - July 6, 1966.

to a crowing cock but did not appear to react to him. Her movements were somewhat erratic for the next several days and on one occasion carried her to the area 1 1/4 miles south of the area. On July 6 her signal could not be received in any of the areas where she had been active until 5:00 p.m. when she was located approximately 660 feet south of her point of capture. The signal remained on the air until 6:30 p.m. when it became faulty and ceased. This bird was not heard or seen after this date.

Bird #2-66.-This cock was night-lighted while roosting on June 17 (Fig. 15). He had been observed moving from his crowing territory into a small alfalfa field to roost. During the 27 days he was monitored his activities appeared to be normal. The home range was approximately 31 acres. His crowing was centered around a Type 1 marsh located in a 75-acre grazed pasture. A small knoll was adjacent to the marsh. His early morning and late afternoon crowing activities were carried on atop this knoll. During the remainder of the day his activities were in the marsh. All signals received from this cock during daylight hours indicated he was active. He moved about considerably on his crowing knoll and in the marsh. His roosting sites were not found.

Visual observations of this male were difficult as he was very wary after being monitored and would retreat for cover at the sight of a person or vehicle. Because of this I was unable to determine if he mated after being monitored. Hens without



Crowing Site



Radio Locations

Figure 15. Crowing site and total range of male #2-66 - June 17 - July 14, 1966.

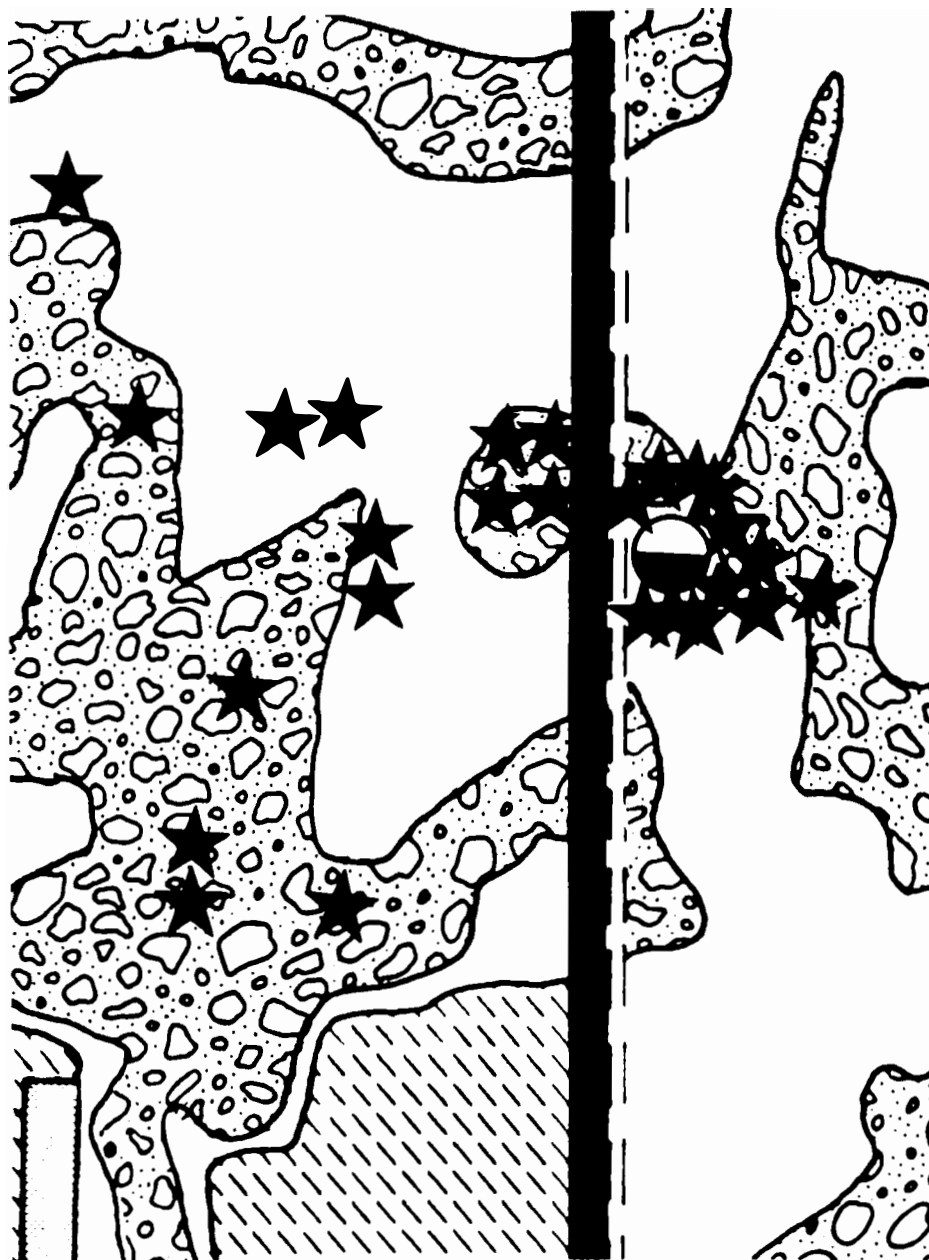
broods were observed on his territory and also night-lighted in the marsh adjacent to his crowing knoll.

After July 6 the bird began to wander about and his locations were widely separated. He had ceased crowing. The last location on this bird, made on July 14, showed him to be 830 feet northeast of his crowing knoll. He was presumed to be entering the molting period and to be seeking seclusion. After radio contact was lost on July 14 he was not seen again.

Bird #3-66.-This male was monitored and released for study on June 22 (Fig. 16). He was captured on his crowing territory in a decoy trap which held another active crowing cock, a good indication that he was still active and defending his territory against intruders.

The total range of this cock was approximately 22 acres. His territory, like that of cock #2-66 was centered around a Type 1 marsh located in a grazed pasture. He too did his crowing on a small knoll. It was on this knoll that he was captured. During the day he retreated into marshes next to his crowing area. He was not known to mate with any hens although hens were observed on his territory.

After the first week of July this male moved off his territory and confined his activities to a large Type 3 marsh to the west of his crowing territory. He was not known to crow again. He was assumed to be molting and in seclusion. On July 14 his signal was lost.



Crowing Site

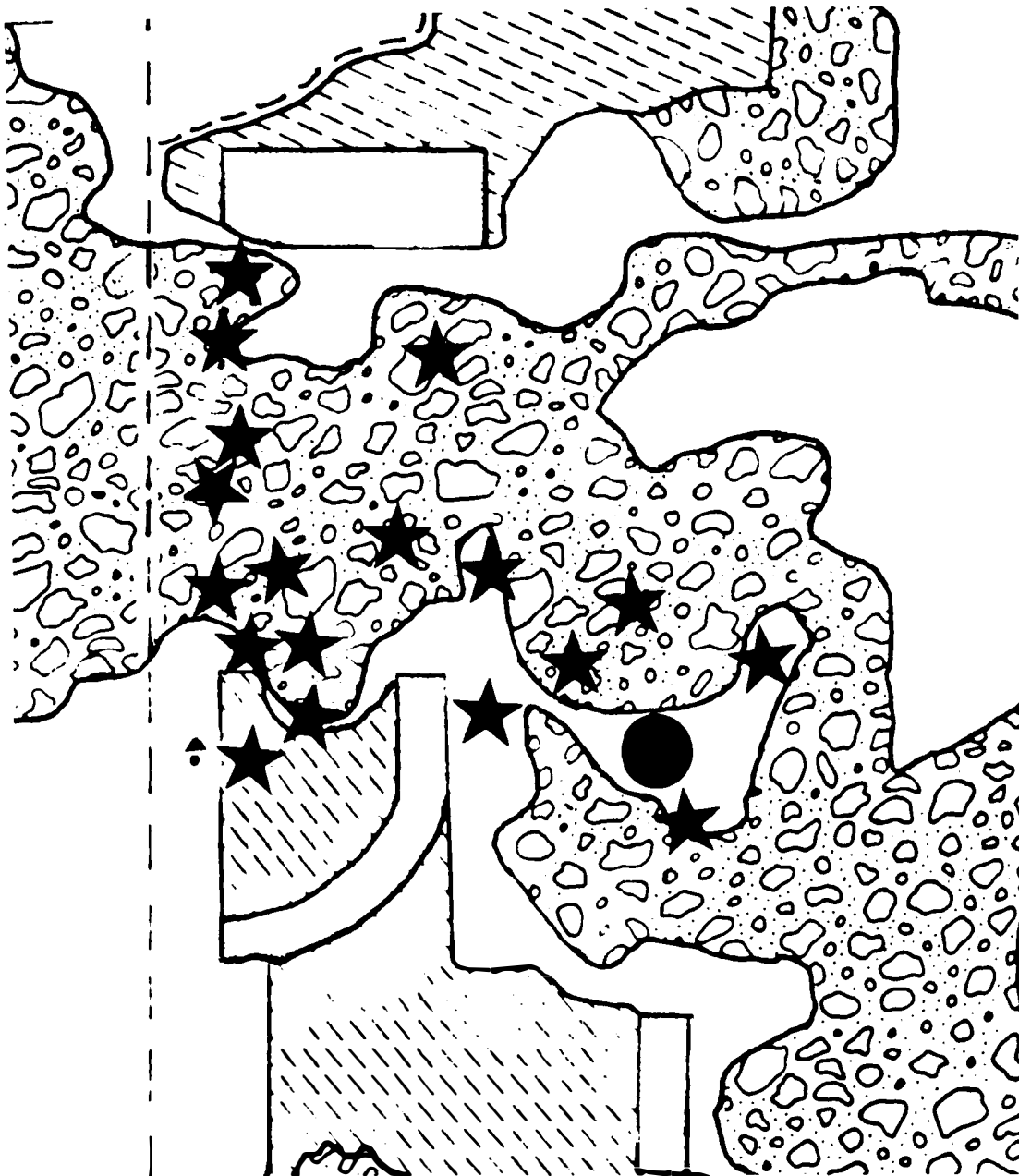


Radio Locations

Figure 16. Crowing site and total range of male #3-66 - June 22 - July 14, 1966.

Bird #4-66.-This hen, captured on her nest on June 24, was incubating 11 eggs which were 4-6 days incubated. She promptly deserted her nest after being instrumented (Fig. 17).

On June 30 her signal was breaking on and off. Not wishing to disturb her in hope that she would attempt to renest. I decided not to retrieve the faulty transmitter. After 3½ weeks the movements and activities of this bird indicated she would probably not renest. She was occupying an area of approximately 25 acres and was not observed responding to any active cocks. Attempts on July 15 to capture her were unsuccessful since her signal was not continuous enough to track her. On July 18 her signal was off the air.



- **Deserted Nest**
- ★ **Radio Locations**

Figure 17. Nest and total range of hen #4-66 following desertion of her nest - June 24 - July 18, 1966.

INTERPRETATIONS OF MOVEMENTS AND BEHAVIOR OF MONITORED PHEASANTS

Ornithologists and mammalogists have long used the concept of home range. Leopold (1933) explained that the fundamental unit in management is the seasonal mobility or cruising radius of the species. Seton (1953:xxxiii) said of this "No wild animal roams at random over the country; each has a home region even if it has not an actual home;" and, "In the idea of a home region is the germ of territory thought." Burt (1943:351) defined home range as "that area, traversed by the individual in its normal activities of gathering food mating... Territory is the protected part of the home range, be it the entire home range or only the nest." Sowl's (1955:48), in applying the concept to waterfowl, refers to home range as "The area in which a bird spends its period of isolation between the breakup of spring gregariousness."

Female Pheasants

Home Range

Home range of pheasants has received little attention. The breeding behavior of cocks on defended territories has been described by various workers but virtually nothing has been written about the home range of the hen. This study revealed the hen occupied a definitive area or home range encompassing all movements while feeding, mating, nesting and caring for the young.

It did not seem to be strongly tied to the crowing territory. The main center of activity appeared to be focused on the nest.

The home range of five instrumented hens was 20, 24, 20, 42 and 38 acres respectively, with an average of 28.5 acres. Long movements made by two hens in attraction to crowing cocks enlarged their ranges. The activity center covered an area of 5-10 acres. Home ranges of the five hens studied included the territory of at least one active, crowing cock. Long movements to crowing territories were exceptions rather than the rule. Three instrumented hens established home ranges closer to crowing cocks than to those cocks whose territories they visited.

Prenesting and Egg-Laying

The ring-necked pheasant is a highly polygamous mater (Leopold 1933). Lack (1940) in his pair-formation classification of birds placed many of the gallinaceous birds among those in which the sexes meet solely for copulation, the female seeking out the male on his display territory. Telemetry data were gathered from five female pheasants during mating activities. Patterns of movements and behavior during this period tend to support Lack's (1940) pair-formation classification, and in all cases the hens met with cocks on their crowing territories only for mating, the pair-bond being only temporary. One hen visited more than one crowing territory. Her first visit was to a cock while reneesting and she

was known to be attracted to his territory only once. She later visited a second cock on two occasions. Four other radio-equipped hens observed were attracted to only one cock. Seubert (1962) found that once a hen joined a cock it seldom shifted to another. These observations indicate a hen associates with only one cock during each nesting.

Only one female showed an abrupt shift to another area for nesting. This shift from the wintering area to the nesting area covered about one mile. The movements may have resulted from the disturbance of instrumentation. Another hen also left the study area but later returned (Kuck 1966). Kimball (1948) reported that pheasants in South Dakota move 7-10 miles from wintering areas to breeding grounds. However, where cover is well dispersed the movement may be minor. Brander (1967) indicated that movements of three female ruffed grouse prior to egg laying ranged over areas considerably larger than those of hen pheasants. Kobriger (1965) reported one female sharptail grouse nest two miles from the dancing ground on which she mated, but he did not indicate her active range.

Oestrus Cycle

Hens, and cocks to a lesser degree, are difficult to observe in harems because they often inhabit dense vegetation. I was not able to determine when the cock first serviced the hen. Little is known of the oestrus cycle of pheasants in the wild but the cycle

has been defined for ruffed grouse. Several people (Schwartz and Schwartz 1949, Taber 1949, and Dale 1956) have reported only that pheasant hens are attracted to the cocks "territory" to court, mate and to feed. Bump et al. (1947) stated that oestrus of ruffed grouse lasts for a period of three to seven days prior to laying the first egg. Brander (1967) further substantiated this when he determined that the female ruffed grouse abruptly entered into the oestrus period and, if mated promptly, oestrus ceased shortly and laying began. My findings indicate that oestrus in pheasants is extended through the egg laying period and that mating occurs throughout this time. For three instrumented hens the first known attraction to a cock with ensuing copulation occurred after the first egg was laid. One hen laid her first egg on or near May 2. She was observed in the harem on May 10. Another hen began laying on May 13 and returned to the harem on the same day. She was observed being pursued by a cock in the harem on May 17. A third hen dropped her first egg on May 7. On May 10 she was again observed on his crowing territory: it was suspected she copulated on May 13.

Two other hens showed a different pattern in that they did not commence egg laying until after being bred. One hen was attracted to a crowing cock on June 3 and to another cock on June 9 and 12. Copulation was not observed. This hen began laying on June 8 and,

since she laid eight eggs, seven of which were fertile, she was bred sometime prior to June 8. The second hen was bred by a cock on June 14 and visited him again the following day. She laid her first egg on June 18. On June 22 and 23 she was again located on the crowing territory. She completed her clutch June 26.

Data from these five hens indicated females were receptive to cocks several days prior to laying the first egg and also during the laying period. It appears the number of eggs in the clutch determines how long the hen is receptive. For example, one hen completed a clutch of 12 eggs and was receptive eight days after laying her first egg. A second hen was receptive four days after the onset of laying and had a clutch of nine eggs. Two other birds returned to crowing territories four days after laying commenced. Both laid clutches of eight eggs. These were the only two hens studied where I was certain of the date they were first attracted to cocks prior to egg laying. The first hen was attracted five days prior to laying and the second four days prior. The oestrus cycle of a hen pheasant apparently begins 4-5 days prior to laying and ends when the clutch is completed. The cycle in South Dakota would average about two weeks during early nesting attempts and 9-10 days during late nesting or renesting (Table 1). Clutches laid by pheasants in Iowa in April and May averaged 12-13 but dropped to 8.5 in July (Hamerstrom 1936).

Table 1. Dates of Laying of First Egg and Periods of Oestrus for Hen Pheasants

Bird No.	Onset of Laying	Number of Eggs Laid	Length of Oestrus Cycle
8-65	May 2	12	April 29 - May 10 (12 days)
10-65	May 13	9	May 8 - May 17 (10 days)
11-65	May 7	10	May 3 - May 13 (11 days)
12-65	June 8	8	June 3 - June 12 (10 days)
14-65	June 18	8	June 14 - June 23 (10 days)

Location of Nests

Three radio-equipped hens were believed to have nested outside the territories of their chosen cocks while two nested within. One hen was observed in copulation within a few yards of her nest site. A second hen was pursued by a cock in the near vicinity of her nest. Locations of nests of hens from the center of their cocks crowing activity were 1,060 feet, 1,090 feet and 1,650 feet respectively. They were apparently not within their cock's crowing territories. There were, however, other cocks whose territories overlapped the nesting site of the various hens but were not successful in attracting the hens to their harems. Behavior of these three hens in selecting a nest site indicates that preferable sites are not always within the cocks crowing territory. Taber (1949) also reported that some hens nest outside the crowing territory and in such instances normally return while off the nest. Seubert (1962), in his study of nesting behavior of hens in an 8-acre enclosure indicated that most hens in harems established their nests within the territories of their cocks and reneest there also.

Nest Attentiveness

All radioed hens but one studied while they were laying went on their nest sometime after mid-day. The exception was hen #14-65 which went to her nest at 10:15 a.m. then laid her final egg. Since she remained there throughout the day this could be

considered her first day of incubation. Just when hens #8 and 10-65 went on their nest was not determined although they were usually there during the afternoon. Hen #11-65 was observed while laying three of her 10 eggs. She was always on or near the nest about 1:00 p.m.

Time hens spent on the nest during egg-laying increased as the number of eggs in the clutch increased. The time spent laying the first and second egg was 1-2 hours as compared to 4-6 hours laying their final eggs. Schladweiler (1965) reported female ruffed grouse apparently spend a minimum of time at the nest while laying. He stated (p12), "A signal monitor of this bird when the first of three eggs was laid showed that she was active near the nest for nearly four hours, became steady for eight minutes, was active for five minutes, and then flew to a point 600 feet from the nest." Bump et al. (1947) reported similar behavior for ruffed grouse. Schladweiler (1965) stated that the ruffed grouse hen flew from the vicinity of the nest. In contrast radioed hen pheasants always walked to and from their nests and were never known to fly.

Rest Periods During Incubation

Prior to departing from the nest with the brood, monitored hens left their nest only to feed unless otherwise disturbed. Leopold (1933) mentioned incubating hen pheasants rest at dawn and 4:00 p.m. Most radioed hens in this study rested only in

afternoons, but one hen left her nest quite consistently during morning hours, always near 10:00 a.m. Only on occasions previously described did other hens leave their nests during the morning hours. Rest periods of incubating females lasted about one hour. Schladweiler (1965) found ruffed grouse fed for about 30 minutes while off the nest each morning and evening.

Movements of Hens With Broods

Brood movement was restricted to the vicinity of the nest until the third week when their range of activity began to broaden. Four brood rearing monitored hens utilized all types of cover available in the vicinity of the nest. Gates (1966) reported a marked hen pheasant with a brood of 11-week-old chicks to be within 1,320 feet of the nest site. He also cited a second marked hen which renested and was later seen with a brood of 4-week-old chicks 792 feet from the site of her original nest. Linder and Agee (1965) stated that nesting and brooding areas for pheasants in Nebraska were close together. Brown (1965) found that brood movement of sharptail grouse was within 600 feet of the nest site for the first three weeks following hatching, with an occasional long movement of up to one half mile following disturbance. Schladweiler (1965) found ruffed grouse broods to be much more mobile. One monitored female moved her brood some 700 feet from the nest the day they were hatched. During the three weeks that he followed

the hen and her brood their minimum daily movements (straight line) were between 700 and 2,000+ feet per day. He also noted a second hen and her brood occupied an area of 30-40 acres two weeks after hatching.

Behavior of Hens With Broods

Leopold (1933) mentioned that all game birds feign more or less when with chicks. Schladweiler (1965) found ruffed grouse to be less defensive as the chicks grew older. He stated (p47), "...the hen was very defensive of the chicks when they were quite young. As they grew older however, especially as they reached the age where they attempted flight, she would flush instead of confronting the intruder." This defensive behavior of female ruffed grouse is explained well by Bump et al. (1947). By comparison, I observed that hen pheasants feign poorly in actual defense of the brood. During the period when the chicks were unable to fly the hen feigns in a weak manner and thus advertises the presence of a brood. For the first three or four days following hatching, hens attempted to decoy me away from their broods by flushing and flying 5-10 yards, then hiding or walking off slowly and conspicuously. Taber (1949) reported this same pattern of behavior in pheasants he studied. When young, chicks would stay hidden in cover until the hen returned and called them together. As they grew older, with short flights being possible, they usually flew or ran to cover after the hen flushed and emitted a loud "chirp" or warning call to them.

Within a few minutes chicks would begin giving distress calls to which the hen would answer and rejoin the brood.

Nest Desertion

Hens readily deserted their nest if they were radio-equipped while laying or incubating. This was attributed to handling and to strangeness of the transmitter. Only one of five incubating females returned to her nest after being instrumented. Another hen did not return to her nest which she had incubated for 18-20 days. Leopold (1933) mentioned the desertion limit of pheasants was 14 days.

Once the hen became adjusted to the transmitter and harness, it was virtually impossible to cause her to desert, especially after she had begun incubation. When one hen was in her seventh day of incubation her transmitter battery went dead and I had to capture her. The first attempt at 11:30 a.m. failed as she escaped the net. By 1:30 p.m. she was back on the nest and capture was successful. Two hours later she was again incubating.

Another hen, when first radioed, abandoned her clutch of nine eggs she had incubated nine days. After becoming accustomed to the transmitter, she returned to her nest three times following capture. A third hen was flushed from her nest four times after incubating 15 days; on each occasion she returned. Schladweiler (1965) reported one monitored female ruffed grouse returned and continued to incubate after being nest trapped in her 17th day of incubation.

Typically, a hen which deserted or had her nest destroyed remained sedentary for a day or two before moving about. If renesting occurred, the activity range of the hen broadened to receive service from the cock then became restricted to the nest area during periods of nesting and brood rearing. If renesting did not occur, the range of the hen remained extensive and there seemed to be no activity center as for nesting hens.

During the 1965 study period nesting hens were more reluctant to flush from their nests and more easily captured than in 1966. Linder and Agee (1965) found hens were more easily captured in some years than others. They related this to a late hatch in 1961 and noted that only one of seven hens failed to return to her nest after being flushed. The reverse of this was noted in 1963 when an early hatch occurred. Peak hatching in South Dakota in 1965 occurred from June 21 to July 4. In 1964 the hatch was much earlier (June 15-21). By comparison, the 1966 hatch was earlier (June 12-18).

Renesting

The pheasant hen in the wild is a persistent nester and commonly renests. During this study two radio-marked hens re-nested and brought off broods in 1965. Both were in early stages of incubation; one was disrupted on May 28, the second on June 9. Two hens which did not renest in 1966 were radioed on June 17

and 27. One was in late incubation, the other early. Seubert (1952) noted hens are more likely to renest if disrupted early in incubation. He also noted that after a certain point in the nesting season, renesting seldom occurs regardless of the stage of incubation.

One hen began renesting 11 days after deserting her previous clutch. A second hen began laying 10 days after her clutch was destroyed. Time between the disruption of the initial clutch and laying of the first egg of the second clutch is "renesting interval" (Seubert 1952 and Gates 1966). It appears that once incubation starts, ovaries begin to regress and the period required for ovaries to redevelop is lengthened accordingly.

Gates (1966) who reported renesting of some marked birds in the wild, found renesting hens selected sites close to their original nest, the average distance being 1,214 feet. I found renesting hens moved only half that distance (approximately 600 feet) from their first nest locations. Gates (1966) also noted that 9 of 11 renesting hens selected hayfields whereas their initial nests were in permanent cover types. One of my instrumented hens selected an alfalfa hayfield for renesting. Her previous nest had been in reed canary grass in a dry marsh. A second hen moved from an oats field to cover on the edge of a Type 3 marsh.

Second clutches are smaller than the first. Clutch sizes dropped from more than 10 eggs to 8 for hen #12-65 and from 9 to 8

for hen #14-65. Seubert (1952) found clutch sizes of initial nests to be statistically greater than those of a second nest; however, the size was not great enough to distinguish an initial nest from a renest. Harris (1951) found the first clutch of four hens averaged 16.5 while second clutches of the same four hens averaged 12.

Male Pheasants

Home Range

Home ranges of two instrumented cocks were 30.6 and 21.8 acres and activity centers 8 and 11 acres. Activity centers of instrumented cock pheasants were around crowing sites. Gullion et al. (1962) defined an activity center for male ruffed grouse as (p619), "The immediate area around a drumming log... the log is the focal point for year-round movements or home range of adult males." Their findings were further substantiated by Schladoweiler (1965) when he noted a radioed male grouse restricted his movement to the vicinity of his drumming log.

Territories

The male pheasant is generally considered territorial because it defends the display portions of its home range from intruders. I was unable to determine how much of the home range was defended territory. Burger (1966) mapped the size of 63 territories during his pheasant study and found they were 1.2-9.8 acres in 1956 and

1.2-6.2 acres in 1957. He attributed difference in size to population density, with smaller territories occurring with an increase in population numbers. These acreages are similar to activity centers which I recorded. Burger (1966) further stated size of territories is of little value if the sample is small or the population density unknown. Robel (1966), in mapping the booming territories of male prairie chickens, found the territory included three definite portions in accordance with booming activity: primary, secondary and tertiary.

I found the two radio-equipped cocks selected knolls in well-grazed pastures as their crowing sites. Vegetation on the knolls was less than six inches high. Dale (1956) noted that the cock regularly crows from many sites within the territory. Burger (1966) found all territories of his study contained areas either barren of vegetation or with short herbaceous cover throughout the spring. Taber (1949) stressed the importance of open ground on territories. Baskett (1947), Taber (1949), and Dale (1956) all concluded that territories are somewhat indefinite with poorly defined boundaries. My data, however, agrees with Burger (1966) in that territories are well defined.

The first week of July marked approximate termination of crowing activities. Both cocks under study ceased crowing by July 6th. Burger (1966) found that by the last week in June most cocks no longer exhibited aggressive behavior. This cessation of crowing

no doubt affects the point in the nesting cycle where the hen will no longer attempt to renest.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

Hens and cocks occupy definite home ranges which encompass all movements. Within the home range is an activity center which for hens was focused on the nest. Activity centers for cocks were centered around the portion of the home range where crowing occurred. Nests of hens were not strongly tied to the crowing territory. However, where preferred nesting cover was adjacent to crowing areas, nesting occurred close by. Management implications would call for good distribution of cover to provide as much edge as possible.

Observations indicated a hen normally associates with one cock during each nesting. Certain males may be more aggressive than others and succeed in attracting a large number of females.

The oestrus cycle for hen pheasants in South Dakota apparently begins 4-5 days prior to laying and ends when the clutch is completed. Cycles would average about two weeks during early nesting and 9-10 days during late or renesting attempts. This indicates a rigid mating pattern which, when coupled with winter stress, could cause high mortality among hens.

Brood movement is restricted to the vicinity of the nest for 2-3 weeks following hatching. This likely accounts for the small number of broods in the 1-2 week age class observed during brood surveys. Restricted movements of broods would indicate

brood surveys sample only those broods which are produced in roadside ditches and field borders. Such would be a factor in population variance when areas of ample cover are compared with areas where field borders and road-right-of-way cover is non-existent.

During years of early nesting, hens deserted their nests more readily as compared to years of late nesting. Hens reneest more readily when disrupted early in incubation. Hens began reneesting 10-11 days after their previous nesting was disrupted. Second clutches were smaller than the first. Late June to early July appeared to be the period in the nesting season after which hens no longer attempted reneesting. This coincides with cessation of crowing which suggests the nesting cycle is dependent upon the crowing cock. Reneesting was apparent in late developing cover. Management for maximum game production should include a good distribution of undisturbed cover.

LITERATURE CITED

- Balham, R. W. and W. H. Elder. 1953. Colored leg bands for waterfowl. *J. Wildl. Mgmt.* 17(4):446-449.
- Baskett, T. S. 1947. Nesting and production of the ring-necked pheasant in north-central Iowa. *Ecol. Monographs* 17(1):1-30.
- Beatty, R. L. 1953. Non-resident pheasant hunting as a source of business and revenue in South Dakota. Univ. of S. Dak., Vermillion. Bul. 31. 20pp.
- Bent, A. C. 1932. Life histories of North American gallinaceous birds. U.S. Natl. Mus. Bul. 162.
- Brander, R. B. 1967. Movements of female ruffed grouse during the mating season. *Wilson Bul.* 79(1):28-36.
- Brown, R. L. 1965. Techniques developed and employed in a study of female sharptail grouse ecology in Montana during 1963, 1964 and 1965. Paper presented at 4th biennial meeting Western States Sage Grouse Comm., Walden, Colo., June, 1965. 4pp. mimeo.
- Bump, G., R. W. Darrow, and W. F. Crissey. 1947. The ruffed grouse. New York State Conserv. Dept., Albany. 915pp.
- Burger, G. V. 1966. Observations on aggressive behavior of male ring-necked pheasants in Wisconsin. *J. Wildl. Mgmt.* 30(1):57-64.
- Burt, W. H. 1943. Territoriality and home range concepts as applied to mammals. *J. of Mamm.* 24:346-352.
- Christensen, R. 1963. A short history of "John Ringneck". *S. Dak. Conserv. Digest* 30(5):12-14.
- Cochran, W. W., D. W. Warner, J. R. Tester, and V. B. Kuechle. 1965. Automatic radio-tracking system for monitoring animal movements. *BioScience* 15(2):98-100.
- Collias, N. E., and R. D. Taber. 1951. A field study of some grouping and dominance relationships in ring-necked pheasants. *Condor* 53(6):265-275.
- Cottam, C. 1956. Uses of marking animals in ecological studies: marking birds for scientific purposes. *Ecology* 37(4):675-681.

- Dahlgren, R. B. 1963. Rhythmic fluctuations in South Dakota pheasant populations and associated adult mortality, 1947-62. Trans. N. Am. Wildl. and Nat. Resources Conf. 28:284-297.
- _____. 1967. The pheasant decline. S. Dak. Dept. of Game, Fish and Parks, Pierre. 44pp.
- Dale, F. H. 1956. Pheasants and pheasant populations. Pages 1-42. In D. L. Allen (Editor), pheasants in North America. The Stackpole Company, Harrisburg; Pennsylvania and The Wildlife Management Institute, Washington, D. C. 490pp.
- Drewien, R. C., H. M. Reeves, P. F. Springer, and T. L. Kuck. 1967. Back-pack unit for capturing waterfowl and upland game by night-lighting. J. Wildl. Mgmt. 31(4):778-783.
- Gates, J. M. 1966. Renesting behavior in the ring-necked pheasant. Wilson Bul. 78(3):309-315.
- Gullion, G. W. 1965. Improvements in methods for trapping and marking ruffed grouse. J. Wildl. Mgmt. 29(1):109-116.
- _____, R. T. King, and W. H. Marshall. 1962. Male ruffed grouse and thirty years of forest management on the Cloquet Forest Research Center, Minnesota. J. Forestry 60(9):617-622.
- Hammerstrom, F. N. Jr. 1936. A study of the nesting habits of the ring-necked pheasant in northwest Iowa. Iowa State Coll. J. Sci. 10(2):173-203.
- Harris, B. K. 1951. The success of renesting in the ring-necked pheasant. Job Completion Report, Federal Aid Project 7R. N. Dak. Game and Fish Dept., Bismarck. 11pp. mimeo.
- Heezen, K. L. and J. R. Tester. 1967. Evaluation of radio-tracking by triangulation with special reference to deer movements. J. Wildl. Mgmt. 31(1):124-141.
- Hipschman, D. 1959. A look at the past half century. S. Dak. Conserv. Digest 28(2):20-31.
- Jackson, W. 1967. Seasonal movements of prairie grouse in South Dakota. M. S. thesis, S. Dak. State Univ. 47pp.

- Kimball, J. W. 1948. Pheasant population characteristics and trends in the Dakotas. Trans. N. Am. Wildl. and Nat. Resources Conf. 13:291-314.
- _____. 1949. The crowing count pheasant census. J. Wildl. Mgmt. 13(1):101-120.
- Klett, A. T. 1957. Banding and marking methods in studying seasonal movements of the sharp-tailed grouse in Morton County, North Dakota. M. S. thesis, Utah State Agr. Coll. Logan. 53pp.
- Kobriger, G. D. 1965. Status, movements, habits and foods of prairie grouse on a sandhills refuge. J. Wildl. Mgmt. 29(4):788-800.
- Kuck, T. L. 1966. Pheasant radio transmitter study. Progress Report Federal Aid W-75-R-7&8. S. Dak. Dept. Game, Fish and Parks, Pierre. 30pp. mimeo.
- _____. 1966. An improved battery hookup for radio-telemetry studies. J. Wildl. Mgmt. 30(4):858-859.
- Labisky, R. F. 1959. Night-lighting: a technique for capturing birds and mammals. Illinois Nat. Hist. Surv. Biol. Notes 40. 11pp.
- Lack, D. 1940. Pair-formation in birds. Condor. 42:269-286.
- Leopold, A. 1933. Game management. Chas. Schribner's Sons, New York. 481pp.
- Linder, R. L. and C. P. Agee. 1965. Regulation of pheasant density through nest abandonment in south-central Nebraska. Trans. N. Am. Wildl. and Nat. Resources Conf. 30:411-422.
- Linder, R. L., D. L. Lyon, and C. P. Agee. 1960. An analysis of pheasant nesting in south-central Nebraska. Trans. N. Am. Wildl. and Nat. Resources Conf. 25:214-230.
- Marshall, W. H. 1963. Studies of movements, behavior and activities of ruffed grouse using radio telemetry techniques. Progress Report. Univ. of Minn. 30pp. Multilithed.
- _____. 1965. Ruffed grouse behavior. BioScience 15(2): 92-94.

- _____ and J. J. Kupa. 1963. Development of radio-telemetry techniques for ruffed grouse studies. Trans. N. Am. Wildl. and Nat. Resources Conf. 28:443-456.
- McEwen, L. C. and R. L. Brown. 1966. Acute toxicity of dieldren and malathion to wild sharp-tailed grouse. J. Wildl. Mgmt. 30(3):604-611.
- Nelson, B. A. 1946. Population characteristics of South Dakota pheasants. S. Dak. Dept. Game, Fish and Parks, Pierre. 3pp. mimeo.
- _____. 1948. Pheasant data from a two-year bag study in South Dakota. J. Wildl. Mgmt. 12(1):20-31.
- Pendleton, R. C. 1956. Uses of marking animals in ecological studies: Labeling animals with radio-isotopes. Ecology 37(4):686-689.
- Robel, R. J. 1966. Booming territory size and mating success of the greater prairie chicken (Tympanuchus cupido pinnatus). Anim. Behav. 14:328-331.
- Rockroth, E. P. 1944. A geology of South Dakota. Part III mineral sources. Univ. of S. Dak., Vermillion. Bul. 15. 255pp.
- Rogers, J. P. 1964. A decoy trap for male lesser scaups. J. Wildl. Mgmt. 28(2):408-411.
- Sanborn County Agriculture. 1959. South Dakota Crop and Livestock Reporting Service. U. S. Dept. Agr., S. Dak. Dept. Agr. 58pp. mimeo.
- Schladweiler, P. 1965. Movements and activities of ruffed grouse (Bonasa umbellus (L.)) during the summer period. M. S. thesis, Univ. of Minn., Minneapolis. 103pp.
- Schwartz, C. W. and E. R. Schwartz. 1949. A reconnaissance of the game birds in Hawaii. Bd. of Comm. of Agr. and For., Territory of Hawaii. 168pp.
- Seton, E. T. 1953. Lives of game animals. Charles T. Bradford, Company, Boston. Vol. 1:337pp.
- Seubert, J. L. 1952. Observations on the reneating behavior of the ring-necked pheasant. Trans. N. Am. Wildl. and Nat. Resources Conf. 17:305-329.

- Slade, N. A., J. J. Cebula, and R. J. Robel. 1965. Accuracy and reliability of biotelemetric instruments used in animal movement studies in prairie grasslands of Kansas. Trans. Kansas Acad. of Sci. 68(1):173-179.
- Sowls, L. K. 1955. Prairie ducks. Wildl. Mgmt. Inst., Washington, D. C. 193pp.
- Taber, R. D. 1949. Observations on the breeding behavior of the ring-necked pheasant. Condor 51(4):153-175.
- _____. 1956. Uses of marking animals in ecological studies: Marking of mammals; standard methods and new developments. Ecology 37(4):686-689.
- Trautman, C. G. 1960. Evaluation of pheasant nesting habitat in eastern South Dakota. Trans. N. Am. Wildl. and Nat. Resources Conf. 25:202-213.
- _____. 1966. Pheasant study area investigations, 1964-65. Progress Report Federal Aid Project W-75-R-7. 26pp. mimeo.
- Weaver, J. E. and F. E. Clements. 1938. Plant ecology. McGraw-Hill Book Company, Inc., New York and London. 601pp.
- Wight, H. M. 1945. The pheasant in Michigan. In W. L. McAtee (Editor), The ring-necked pheasant. The American Wildlife Institute, Washington, D. C. 320pp.

APPENDIX

Appendix Table 1. Field Battery Life (1965) E132 2.7 Volt
Mercury Battery

Bird No.	Date/ On	Date/ Off	No. Days On	Remarks
1-65	3/9	----	0	No signal after bird escaped.
2-65	3/10	3/23	13	Signal fair at recovery.
3-65	3/11	3/24	13	Signal fair at recovery.
4-65	3/24	4/2	10	Signal fair 4/1, no signal 4/2.
5-65	3/25	3/27	2	Good signal 3/26, very weak when recovered 3/27.
6-65	3/27	3/28	1	Good signal 3/27, no signal 3/28.
7-65	4/1	4/7	7	Signal weak and faulty at time of recovery
8-65	4/14	5/17	33	Signal weak 5/15, signal off 5/17.
9-65	4/14	5/11	28	Signal weak 5/10, no signal 5/11.
10-65	5/3	5/27	25	Signal weak 5/24, very weak at recovery 5/25.
10-65	5/27	6/2	8	Signal good 6/1, no signal 6/2.
11-65	5/3	5/25	23	Signal weak at recovery 5/25.
12-65	5/28	6/24	28	Weak signal 6/23, signal off at time of capture 6/24.
12-65	6/24	7/21	27	Signal weak at time of capture.
12-65	7/21	7/28	41	Continued to transmit in office until 8/30.
13-65	6/1	6/4	3	Signal weak 6/3, no signal 6/4.
14-65	6/9	7/1	23	Faulty signal, transmitter removed.
14-65	7/16	8/13	39	Continued to transmit in office until 8/23.
15-65	6/15	7/9	29	Signal weak at time of capture.
15-65	7/9	7/12	3	Signal strong at time of capture.

Appendix Table 2. Field Battery Life (1966) RM-1 2.7 Volt
Mercury Battery

Bird No.	Date/ On	Date/ Off	No. Days On	Remarks
1-66	6/17	7/6	19	Signal very strong prior to malfunction 7/6.
2-66	6/17	7/14	27	Signal fair 7/13, no signal 7/14.
3-66	6/22	7/14	22	Signal fair 7/13, no signal 7/14.
4-66	6/24	7/18	24	Signal good prior to malfunction 7/18.
5-66	7/26	8/15	20	Signal good on 8/12, no signal 8/15.

Appendix Table 3. Degree of error for nesting (inactive) hens
on the Rifle-Calahan Study Area

Bird No.	No. Locations while nesting	Error Range (°)		Distance of nest site from		Mean Error (°)	
		Antenna		A B		Antenna	
		A	B	A	B	A	B
12-65	103	0-5.9	0.1-7.6	1584'	1032'	1.4	1.8
14-65	46	0-8.0	0.3-6.7	924'	1815'	2.4	2.5
15-65	41	0-4.1	0-10	1848'	726'	1.2	0.8

Appendix Table 4. Summary of Radio-Tracking Data on 15 Adult Pheasants, Rifle-Calahan Study Area, Sanborn County, March 9 - August 13, 1965

Bird No.	Sex*	Date on/off	Days on	Locations	Last Record*
1-65	M	3/9 --	0	0	Escaped 3/9, Radio Mal-function, Shot by hunter 10/16, 1965 NR
2-65	F	3/10-3/23	13	17	Predator Kill, TR
3-65	F	3/11-3/24	13	19	Feet caught in harness, TR
4-65	F	3/24-4/1	10	13	Signal off, NR
5-65	M	3/25-3/27	2	2	Died, trap injury, TR
6-65	F	3/27 --	1	1	Signal off, NR
7-65	F	4/1-4/7	7	3	Faulty signal, TR
8-65	F	4/14-5/17	33	96	Signal off, NR
9-65	F	4/14-5/11	28	90	Signal off, NR
10-65	F	5/3-6/2	31	177	Signal off, NR
11-65	F	5/3-5/25	23	156	Predator Kill, TR
12-65	F	5/28-7/28	63	278	Mower Kill, TR
13-65	F	6/1-6/4	3	10	Signal off, NR
14-65	F	6/9-7/1; 7/16-8/13	52	240	Terminated project, TR
15-65	F	6/15-7/12	28	133	Moved off study area, TR
Totals			307	1235	

* M - Male

F - Female

**NR - Transmitter not recovered

TR - Transmitter recovered

Appendix Table 5. Summary of Radio-Tracking Data on Five Adult Pheasants, Rifle-Calahan Study Area, Sanborn County, June 17 - August 15, 1966

Bird No.	Sex ¹	Date on/off	Days on	Locations	Remarks ²
1-66	F	6/17-7/6	19	20	Transmitter Malfunction, NR
2-66	M	6/17-7/14	27	23	Signal off, NR
3-66	M	6/22-7/14	22	24	Signal off, NR
4-66	F	6/24-7/18	24	17	Transmitter Malfunction, NR
5-66	F	7/26-8/15	20	25	Signal off, NR

¹M-Male, F-Female

²NR-Transmitter not recovered